Journal of Chemical Education

Published by

Division of Chemical Education of The American Chemical Society

Easton, Pa.

Entered as Second-class Matter, January 31, 1924, at the Post Office at Easton, Pa., under the act of March 3, 1859. Accepted for mailing, at special rate of postage provided for in Section 1103 Act of October 3, 1917, authorized January 31, 1924.

Copyright, 1930, by Division of Chemical Education, American Chemical Society

The Journal of Chemical Education is indexed in the Education Index and Industrial Arts Index

Vol. VII **March, 1930** **No. 3**

CONTENTS

	Page
Frontispiece	492
Editor's Outlook	493
The Dialyzer	498
European Laboratory Experiences of an Early American Agricultural Chemist—Dr. Evan Pugh (1828–1864)	499
Chemical Actions of Light. Max Bodenstein	518
Symposium on "Selecting the Chemist-Elect"	530
The Moore Laboratory of Chemistry at Amherst College	542
The Chemist as an Expert Witness. William M. Dehn	556
Radio Reactions. Saul B. Arenson	562
Concerning the Future of the One-Year Chemistry Course. O. F. Stafford	565
Should Laboratory or Recitation Have Precedence in the Teaching of High-School Chemistry? Rosalie M. Parr and Mable A. Spencer	571
An Investigation of Study Methods Used by High-School Chemistry Students. Otis A. Crosby	587
Lecture Experiment on the Influence of the Solvent on the Speed of Reaction. H. S. van Klooster	589
The Numerical Solution of Equilibrium Problems. Horace G. Deming	591
A Continuous Extractor for Solids. John H. Gardner and Edward B. W. Kerone	593
A Review of Some Applications of the Cannizzaro Reaction to Aliphatic Aldehydes. Robert C. Elderfield	594
Aldol and Related Condensations as a Tool in Teaching Organic Chemistry. Henry Price Howells	597
Objective Tests in Organic Chemistry. J. W. Ince and Cecil L. Brown	610
The Recovery of Iodine as Sodium Iodide from Waste Iodide Solutions. W. D. Bonner and K. Masaki	616
The Alkali Carbonate Fusion in Qualitative Analysis. Jacob Cornog and Herschel Hopson	618
Minutes of the Mid-Winter Meeting of the Executive Committee of the Division of Chemical Education of the A. C. S.	624
The Chemistry Student:	
The Theory of Types—A Satirical Sketch. Harold B. Friedman	633
The Game of Chemists. Esther Elking	636
Carbon Dioxide. III. Its Commercial Manufacture. Elton L. Quinn	637
Explosives; A Burlesque Lecture. Louis C. Jordy	653
Former Royal Hunting Lodge Now Paper Laboratory	660
Contest for High-School and Freshman Students	661
Winners in Fourth "What Is Wrong?" Contest	663
A Simple Bisulfide Spectroscope. Howard James	666
The Library	668
Correspondence:	
Benjamin Silliman, 1779–1864—A Correction	671
Correspondence-Study Course in Inorganic Preparations	671
"Chlorox" Problem for Chemistry Students	672
Avogadro and Euclid	673
Chemical Digest:	
Qualities of Merit in Good and Poor Teachers	675
The Popularization of Science	678
Hunter College Journalism Club	680
Abstracts	682

Apparatus, Laboratory Practice, and Demonstrations: The Kinetics of the Reaction between Formaldehyde with Bisulfite and Sulfite. Demonstration Experiment. Demonstration Experiment on Oxidation-Reduction. An Automatic Buret. Crucible with

Handle. Automatic Pipet Filler. A Continuous Flow Non-Splash Wash Bottle. An Improved Hydrogen Sulfide Generator. A General Method for Prevention of Flask Bumping during Boiling. Graduate Cylinder Protector. A Simple Laboratory Vacuum Regulator. Automatic Cut-Off Device for a Gas-Fired Laboratory Mercury Still. Wax Bottle Support. Emulsifier. Stabilizing Sodium Thiosulfate Solutions. Anhydrone, $Mg(ClO_4)_2$. A Perfect Substitute for P_2O_5 to Be Used as a Drying Agent. Glass and Glass-Making Materials. Adaptation of the Diphenylcarbazide Test for Mercury to the Scheme of Qualitative Analysis. Chemical Analysis Facilitated by Laboratory Appliances: Applications to the Determination of Theobromine and to the Testing of Cola Preparations. A Continuous Extractor. Standardized Ground-In Connections. Note on Preparation of Collodion Bags. Cleaning Volumetric Glassware. A New Freezing Mixture. Blocking-Out Undesirable Backgrounds in Photographs. The Determination of Gelatin in Dilute Solutions. Measuring the Millionth of a Centigrade Degree to Test Modern Scientific Theories. **Teaching Objectives, Methods, and Suggestions; Curricula:** Teaching Oxidation and Reduction. Chemical Engineering Education. New Elementary Science Course Explains Radio, Television, and Talkies. The Individual Plan of Graduate Study at the University of Iowa. **Keeping Up with Chemistry:** The Fundamental Atomic Quantities and Atomic Weight. An Isotope of Oxygen, Mass 17, in the Earth's Atmosphere. Effect of Neutral Salts on H-Ion Concentration. Some New Aspects of the Electrochemical Oxidation of Organic and Inorganic Compounds. Part I. The Electrochemical Oxidation of Aromatic Hydrocarbons. Part II. The Electrochemical Preparation of Vanillin, Saccharin, and Dyestuffs. A Theory of Liquid Film Formation. Recent Reactions between Theory and Experiment. The Raman Effect: The Constitution of Hydrogen Gas. Chemicals in the Movies. Chemical Statistics. Mobile Helium Repurification Plant. Bingham Canyon's Great Copper Camp. Part 2. Electrification of a Large Gold Mine. Amyl Alcohol from the Pentanes. The Manufacture of Anhydrous Ethyl Alcohol. Solvents. Cyanamide and Its Uses. Synthetic Camphor Is Made in New Jersey. A New Method for the Production of Pure Beryllium Oxide from Beryllium Ores. Konel. Titanium Dioxide: A Revolutionizing Factor in the Pigment Market. Vanadium. Iron Alloys Committee. The Welding of Ferrous and Non-Ferrous Metals by the Atomic Hydrogen Flame. The Development of Modern Methods of Testing Lubricating Oils. Rubber Cements. Vulcanization of Rubber. Natural and Synthetic Rubber. I. Products of Destructive Distillation. II. Reduction of Isoprene by $Na\text{-}NH_3$. III. Dimethyloctadiene. Absorption of Oxygen by Rubber. Recent Developments of Window Materials and Fabrics for Transmitting Ultra-Violet Radiations. New Tests of Ultra-Violet Ray Transmitting Glass. Hygienic Effects of Ultra-Violet Radiation in Daylight. Fused Quartz Window Panes in World's Largest Solarium. **Scientific Reviews and Bibliographies:** Properties of Vanadium and Its Compounds. **Historical and Biographical:** Ernest Rutherford. Ernest Rutherford. Recipients of the Nobel Prize in 1908. In Honor of Mme. Curie. Kasimir Fajans. Robert Robinson Succeeds Perkin, Jr. Edwin E. Slosson. Frank Austin Gooch. Frank Austin Gooch. William Henry Perkin, Jr. Edgar Fahs Smith. Richard Zsigmondy, 1865–1929. Theodore William Richards. Charles Moureu, 1862–1929. Charles Moureu. Charles Moureu. Paul Schutzenberger. Svante Arrhenius. Sir Humphry Davy, 1778–1829. The Life of Sir Humphry Davy. Paracelsus. Justus von Liebig's Geburtshaus. Briefe von Justus Liebig. Liebig-Wöhler Feier in Darmstadt am 7, Juli, 1928. Ortho, Meta, Para. I. History of the Introduction of the Prefixes into Chemical Nomenclature. II. Benzene and Some of Its Derivatives. III. Kekulé; the Constitution of Aromatic Substances. IV. Position Isomerism; Early Views and Difficulties. V. Position Isomerism; the Problem Solved. Distillation Methods, Ancient, and Modern. **Educational Measurements and Data:** Ability Grouping in Theory and Practice. The Ability Group. Criteria for Judging Content of a General Science Course. **The Philosophy of Education:** What Do Our Colleges Need Most? Three Enemies of Education—Notebooks, Credits, and Examinations. High-School Diploma Often Meaningless. A Forecast of Secondary Curriculum Revision. **The Philosophy of Science:** The Impact of Science upon Religion. Research and Labor: A Chemist Looks at Modern Life. The Popularization of Science. Industrial Progress Made through Research and Its Economic Importance. **Professional:** Qualities of Merit in Good and Poor Teachers. Academic and Professional Training of Science Teachers in Wisconsin. Investigating the Value of Professional Courses in Education. Is There an Age Dead-Line in the Scientific and Engineering Professions? Educating the Educators. Part I. The Contribution of the Graduate Schools. Who Shall Supervise College Teaching? Fifty-Five New College Presidents. **Contemporary News and Comments in Chemistry and Education:** Organic Symposium at Princeton. Kasimir Fajans, Holder of the George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University, 1930. Dedication of the George Herbert Jones Laboratory at the University of Chicago. Memorial Service for Edgar Fahs Smith. The Provost of the University of Pennsylvania Presiding. Dr. Arthur Harden: Nobel Prizeman. Sir Frederick Gowland Hopkins: Nobel Prizeman. The Davy Medal—Gilbert N. Lewis. In Honor of Mme. Curie. Robert Robinson Succeeds Perkin, Jr. Commission on the Reform of the Nomenclature of Organic Chemistry. Iron Alloys Committee. The Advisory Committee on National Illiteracy. **Foreign Chemical and Educational Conditions:** One Hundred Years of Chemistry in the Stüttgart Technical College. **General:** The Publication of Papers from Research Institutions. The Binding Influence of a Library on a Subdividing Profession. The Reaction of American Public Opinion to Chemical Warfare. The World-Wide Influence of Industrial Research. Sanitary Control of Swimming Pools.

Local Activities 702
Recent Books 721

DIVISION OF CHEMICAL EDUCATION OF THE A. C. S.

OFFICERS

Chairman: JOHN N. SWAN, University of Mississippi, University, Miss.
Vice-Chairman: MARTIN V. MCGILL, Lakewood High School, Lakewood, Ohio.
Secretary: ROSS A. BAKER, Syracuse University, Syracuse, New York.
Treasurer: ROSALIE M. PARR, University of Illinois, Urbana, Illinois.
Editor-in-Chief: NEIL E. GORDON, The Johns Hopkins University, Homewood, Baltimore, Maryland.

COMMITTEES

Executive Committee: JOHN N. SWAN, University of Mississippi, University, Mississippi, *Chairman;* M. V. MCGILL, *Vice-Chairman;* R. A. BAKER, *Secretary;* ROSALIE M. PARR, *Treasurer;* B. S. HOPKINS, WILLIAM MCPHERSON, and WILHELM SEGERBLOM, *Past Chairmen;* NEIL E. GORDON, *Editor-in-Chief.*

Aids to Visual Instruction in Chemistry (Estd. 1926): M. V. MCGILL, Lakewood High School, Lakewood, Ohio, *Chairman;* L. A. ASTELL, CLARENCE E. BAER, I. L. NIXON, R. C. RUNKLE.

Chemical Education of the Non-Collegiate Type (Estd. 1928): R. E. BOWMAN, Wilmington Trade School, Wilmington, Delaware, *Chairman;* HERMAN A. ERNST, ARTHUR GUILLAUDEU, MORRIS LAWRENCE, ALLEN ROGERS, R. E. ROSE.

Correlation of High-School and College Chemistry (Estd. 1929): NEIL E. GORDON, The Johns Hopkins University, Homewood, Baltimore, Maryland, *Chairman;* LOUIS W. MATTERN, LYMAN C. NEWELL, WILHELM SEGERBLOM.

Labels (Estd. 1929): JOHN M. MICHENER, Wichita High School East, Wichita, Kansas *Chairman;* L. R. LITTLETON, W. O. WALKER.

Major Topic Organization of High-School Chemistry (Estd. 1928): H. A. CARPENTER, West High School, Rochester, New York, *Chairman;* V. J. CHAMBERS, B. C. HENDRICKS, J. H. JENSEN, GRETCHEN KAUFMAN, H. R. SMITH.

Minimum Equipment for High-School Chemistry (Estd. 1926): J. H. JENSEN, Northern State Teachers' College, Aberdeen, South Dakota, *Chairman;* W. G. BOWERS, F. C. MABEE, J. H. NORTON, C. R. OTTO, C. H. STONE.

Naming and Scope of Committees (Estd. 1927): WILHELM SEGERBLOM, Phillips Exeter Academy, Exeter, New Hampshire, *Chairman;* A. J. CURRIER, J. C. HESSLER, L. R. LITTLETON, G. H. WHITEFORD.

Order of Presentation of Recitation and Laboratory Work (Estd. 1928): FRANK M. GREENLAW, Rogers High School, Newport, Rhode Island, *Chairman;* M. C. COLLISTER, O. E. MADISON, ROSALIE M. PARR.

Preparation of High-School Chemistry Teachers (Estd. 1928): A. J. CURRIER, Pennsylvania State College, State College, Pennsylvania, *Chairman;* HENRIETTA HAYDEN, LOUIS W. MATTERN.

Professional Spirit among High-School Teachers (Estd. 1928): LOUIS W. MATTERN, McKinley High School, Washington, D. C., *Chairman;* JOHN FULTON, H. M. MOSELEY, M. C. SNEED, C. H. STONE.

Research Problems (Estd. 1923): W. H. CHAPIN, Oberlin College, Oberlin, Ohio, *Chairman.*

Women's Club Study Course in Chemistry (Estd. 1924): HARRISON HALE, University of Arkansas, Fayetteville, *Chairman;* W. F. KEOHAN.

SENATE OF CHEMICAL EDUCATION

Alabama: J. R. SAMPEY, Howard Coll., Birmingham; A. S. BENHAM, Paul Hayne H. S., Birmingham; J. T. MACKENZIE, 4300 Glenwood Ave., Birmingham.

Arizona: L. E. ROBERTS, U. of Arizona, Tucson; ARTHUR L. PHELPS, Phoenix Jun. Coll., Phoenix; F. G. HAWLEY, Internatl. Smelting Co., Box 351, Miami.

California: *Sacramento*, J. H. NORTON, Sacramento Jun. Coll., Sacramento; ASA L. CAULKINS, High School, Stockton; JOHN C. BRISTOW, State Dept. of Agri., Sacramento; *San Francisco*, LIONEL DUSCHAK, 412 Hobart Bldg., San Francisco; *Southern California*, J. E. BELL, Calif. Inst. of Tech., Pasadena; ISABELLE WILSON, 3222 W. 60th St., Los Angeles; F. S. PRATT, Pacific R. & H. Chem. Corp., El Monte, Los Angeles Co.

Colorado: G. H. WHITEFORD, Colo. Agri. Coll., Ft. Collins; ROBT. COLLIER, Southside H. S., Denver; A. R. NEES, Great Western Sugar Co., 21st and Blake Sts., Denver.

Connecticut: G. ALBERT HILL, Wesleyan U., Middletown; STANLEY H. REED, 134 N. Beacon St., Hartford; ELBERT M. SHELTON, Cheney Bros., Manchester.

Delaware: ALBERT S. EASTMAN, U. of Delaware, Newark; ALLEN N. ZECHIEL, Tower H. S., Wilmington; HOLGER V. BERG, The Krebs Pigment & Chem. Co., Newport.

District of Columbia: Jos. A. MULDOON, Georgetown U., Washington; ALLEN J. MARSH, McKinley H. S., Washington; MARGARET R. TAYLOR, Western H. S., Washington.

Florida: V. T. JACKSON, U. of Florida, Gainesville; FRANCES WEST, St. Petersburg Jun. Coll., St. Petersburg; L. M. DRAKE, West Fairview Ave., Daytona.

Georgia: J. S. GUY, Emory U., Atlanta; T. W. CLIFT, Technical H. S., Atlanta; L. B. LOCKHART, Law & Co., Inc., Atlanta.

Illinois: *University of Illinois*, JOHN C. HESSLER, Knox Coll., Galesburg; H. W. GARNETT, 205½ North St., Normal; L. F. NICKELL, Monsanto Chem. Co., E. St. Louis; *Chicago*, H. R. SMITH, Lake View H. S., Chicago; DAVID KLEIN, Wilson Laboratories, Chicago.

Indiana: M. G. MELLON, Purdue U., Lafayette; FRANK B. WADE, Shortridge H. S., Indianapolis; H. W. RHODEHAMEL, Eli Lilly Co., Indianapolis.

Iowa: *Ames*, WINFRED F. COOVER, Iowa State Coll., Ames; FRANK E. GOODELL, 10th and Locust Sts., Des Moines; DALE L. MAFFITT, 10th and Locust Sts., Des Moines; *Iowa*, EDWARD BARTOW, State U. of Iowa, Iowa City; NEIL LUTE, 1595 Atlantic St., Dubuque; H. J. BROWNLEE, The Quaker Oats Co., Cedar Rapids.

Kansas: H. W. BRUBAKER, Kansas State Agri. Coll., Manhattan; E. B. KEITH, Kansas State Agri. Coll., Manhattan; W. F. BROWN, Kansas State Agri. Coll., Manhattan.

Kentucky: R. N. MAXSON, U. of Kentucky, Lexington; MARIE BORRIES, Girls' H. S., Louisville; H. A. SNYDER, Kentucky Color & Chem. Co., Louisville.

Louisiana: H. W. MOSELEY, Tulane U. of Louisiana, New Orleans;

WALTER G. ALLEE, Newman Manual Training School, New Orleans; FRANK W. LIEPSNER, 420 Camp St., New Orleans.

Maine: C. A. BRAUTLECHT, U. of Maine, Orono; J. F. KOLOUCH, Mapleton H. S., Mapleton; E. SUTERMEISTER, S. D. Warren Co., Cumberland Mills.

Maryland: E. E. REID, Johns Hopkins University, Baltimore; FITZGERALD DUNNING, Hynson, Westcott & Dunning, Charles and Chase Sts., Baltimore.

Massachusetts: J. S. CHAMBERLAIN, Mass. Agri. Coll., Amherst; LAURA P. PATTEN, Medford H. S., Medford; G. J. ESSELEN, 276 Stuart St., Boston.

Michigan: O. E. MADISON, Coll. of City of Detroit, Detroit; A. C. STITT, Ann Arbor H. S., Ann Arbor; GEORGE WALKER, 9601 American Ave., Detroit.

Minnesota: W. M. SANDSTROM, U. of Minnesota, Minneapolis; F. H. SCHULTZ, Minnehaha Academy, Minneapolis; W. F. HOFFMAN, N. W. Paper Co., Cloquet.

Mississippi: A. E. WOOD, Mississippi Coll., Clinton; C. O. HINTON, Perkinston; C. A. LAMBERT, Hercules Powder Co., Hattiesburg.

Missouri: *Kansas City*, PERRY F. JOHNSON, Park Coll., Parkville; CARL F. GUSTAFSON, 109 W. 61st St., Kansas City; L. C. HOWE, Cudahy Packing Co., Kansas City; *St. Louis*, L. MCMASTER, Washington U., St. Louis; W. R. TEETERS, 5458 Clemens Ave., St. Louis; GEO. S. ROBINS, 511 S. 2nd St., St. Louis; *University of Missouri*, MARY V. DOVER, U. of Missouri, Columbia; OTIS M. WEIGLE, Westminster Coll., Fulton; K. K. KERSHNER, Rolla.

Montana: A. E. KOENIG, State School of Mines, Butte; DON C. EVANS, Park Co. H. S., Livingston; GLENN WILES, State Board of Health, Helena.

Nebraska: B. C. HENDRICKS, U. of Nebraska, Lincoln; J. J. GUENTHER, Omaha Technical H. S., Omaha; L. B. PARSONS, Cudahy Packing Co., Omaha.

Nevada: GEO. W. SEARS, U. of Nevada, Reno; E. C. STRENG, 766 W. St., Reno; C. W. DAVIS, Bureau of Mines, Reno.

New Hampshire: HERMAN C. FOGG, U. of New Hampshire, Durham; WILHELM SEGERBLOM, Phillips Exeter Academy, Exeter; G. A. RICHTER, Brown Co., Berlin.

New Jersey: WM. FOSTER, Princeton U., Princeton; R. B. WHITMOYER, Senior H. S., Atlantic City; JOHN B. FOSTER, Roseville Ave. and Orange St., Newark.

New Mexico: J. D. CLARK, U. of New Mexico, Albuquerque; C. W. BOTKIN, Box 95, State Coll.; JOHN H. GRIFFITH, State Teachers' Coll., Silver City.

New York: *Eastern New York*, CHARLES B. HURD, Union Coll., Schenectady; KATHARINE WEAVER, Emma Willard School, Troy; E. R. BAINBRIDGE, Duriron Co., 160 S. Manning Blvd., Albany; *New York City*, C. CARPENTER, Columbia U., New York; GEO. H. BRUCE, Horace Mann School for Boys, New York; H. L. FISHER, U. S. Rubber Co., Passaic, N. J.; *Rochester*, MARION LOUGEE, Keuka Coll., Keuka Park; H. A. CARPENTER, West H. S., Rochester; ERLE M. BILLINGS, 343 State St., Rochester; *Syracuse*, R. A. BAKER, Syracuse U., Syracuse; LUCY E.

LATHAM, Sherrill H. S., Sherrill; WASHINGTON PLATT, The Borden Co., Syracuse; *Western New York*, M. K. BUCKLEY, U. of Buffalo, Buffalo; VAN L. BOHNSON, du Pont Rayon Co., Sta. B, Buffalo.

North Carolina: L. F. WILLIAMS, State Coll. of Agri., Raleigh; J. O. HALVERSON, Dept. of Agri., Raleigh.

North Dakota: G. A. ABBOTT, U. of North Dakota, Grand Forks; DELOS HARGRAVE, Grand Forks H. S., Grand Forks.

Ohio: W. H. CHAPIN, Oberlin Coll., Oberlin; MARTIN V. MCGILL, Lakewood H. S., Lakewood; W. E. GANGLOFF, 27 Parkwood Place, Cincinnati.

Oklahoma: H. M. TRIMBLE, Okla. A. & M. Coll., Stillwater; CLIFF R. OTTO, Central Teachers' Coll., Edmond; CLAUDE L. JOHNSON, Marland Lab., Ponca City.

Oregon: R. K. STRONG, Reed Coll., Portland; W. V. GREEN, Washington H. S., Portland; PERRY CRAWFORD, Calif. Oregon Power Co., Medford.

Pennsylvania: *Central Pennsylvania*, A. J. CURRIER, Pennsylvania State Coll., State College; L. PAUL MILLER, Central H. S., Scranton; C. C. MITCHIE, New Jersey Zinc Co., Palmerton; *Erie*, R. E. LEE, Allegheny Coll., Meadville; W. E. COON, East H. S., Erie; M. A. KRIMMEL, Hammermill Paper Co., Erie; *Lehigh Valley*, J. SCOTT LONG, Lehigh U., Bethlehem; E. F. MARSIGLIO, 230 Porter St., Easton; *Philadelphia*, OWEN L. SHINN, U. of Pennsylvania, Philadelphia; WM. B. MELDRUM, Haverford Coll., Haverford; ROBT. H. BRADBURY, South Philadelphia H. S., Philadelphia; *Pittsburgh*, T. R. ALEXANDER, JR., Carnegie Inst. of Tech., Pittsburgh; E. R. CARSON, South Hills H. S., Ruth St., Pittsburgh; J. C. WHETZEL, American Sheet and Tin Plate Co., 210 Semple St., Oakland Sta., Pittsburgh.

Rhode Island: NORRIS W. RAKESTRAW, Brown U., Providence; FRANK W. GREENLAW, Rogers H. S., Newport; A. H. FISKE, Rumford Chem. Works, Providence.

South Carolina: J. E. COPENHAVER, U. of South Carolina, Columbia; LOUISE A. AGNEW, Due West Woman's Coll., Due West; C. D. BLACKWELDER, Box 226, Greenville.

South Dakota: J. H. JENSEN, Northern Normal and Ind. School, Aberdeen; ROBERT O. DOTT, Pierre; GUY FRARY, State Chem. Lab., Vermilion.

Texas: *Central Texas*, F. W. HOGAN, Texas Christian Univ., Fort Worth; W. A. CLARK, JR., Plemons; F. B. PORTER, Fort Worth.

Utah: C. E. MAW, Brigham Young U., Provo; T. B. BRIGHTON, U. of Utah, Salt Lake City; ALPHA JOHNSON, Utah Copper Co., Garfield.

Vermont: P. C. VOTER, Middlebury Coll., Middlebury; L. O. JOHNSON, Rutland H. S., Rutland; OTTO WINESTOCK, Perkinsville.

Virginia: ARTHUR C. BENTON, U. of Virginia, Charlottesville; LEROY L. SUTHERLAND, Staunton Military Academy, Staunton; E. W. MAGRUDER, Royster-Guano Co., Norfolk.

Washington: GRETCHEN KAUFMAN, R. 2, Box 299, Bellingham; F. A. RANTZ, R. 6, Box 277, Seattle; ZAHLIA J. GAILEY, Crescent Mfg. Co., Seattle.

West Virginia: F. E. CLARK, U. of West Virginia, Morgantown; W. A. MUDGE, Internatl. Nickel Co., Huntington.

Wisconsin: J. H. MATTHEWS, U. of Wisconsin, Madison; M. J. W. PHILLIPS, West Allis H. S., West Allis; HENRY B. MERRILL, A. F. Gallun & Sons, Milwaukee.

LOCAL ORGANIZATIONS THROUGH WHICH CHEMICAL EDUCATION IS FUNCTIONING

ALABAMA: **Alabama Section of the A. C. S.:** GEO. J. FERTIG, *Chairman;* C. S. WHITLET, *Secretary,* 3600 11th St., Birmingham.

ARIZONA: **Arizona Section of the A. C. S.:** J. D. SULLIVAN, *Chairman;* ROSALIND KLASS, *Secretary,* 834 E. Helen Street, Tucson.

ARKANSAS: **Arkansas Section of the A. C. S.:** HARRISON HALE, *Chairman;* LYMAN E. PORTER, *Secretary,* University of Arkansas, Fayetteville.

CALIFORNIA: **California Section of the A. C. S.:** C. G. MAIER, *Chairman;* L. ROSENSTEIN, *Secretary,* 1112 Market Street, San Francisco.

Sacramento Section of the A. C. S.: R. A. STEVENSON, *Chairman;* R. P. TUCKER, *Secretary,* Capitol Extension Building, Sacramento.

Southern California Section of the A. C. S.: CHARLES J. ROBINSON, *Chairman;* MARK WALKER, *Secretary,* 1984 Oak Street, South Pasadena

COLORADO: **Colorado Section of the A. C. S.:** A. R. NEES, *Chairman;* L. W. HARTKEMEIER, *Secretary,* 817 Fifteenth Street, Golden.

CONNECTICUT: (*See* **New England States**).

DELAWARE: **Delaware Section of the A. C. S.:** A. W. KENNEY, *Chairman;* A. L. FOX, *Secretary,* P. O. Box No. 525, Wilmington.

DISTRICT OF COLUMBIA: **District of Columbia Section of the A. C. S.:** HARDEE CHAMBLISS, *Chairman;* GEORGE S. EDELEN, *Secretary,* Business High School, Washington.

FLORIDA: **Florida Section of the A. C. S.:** R. S. BLY, *Chairman;* R. C. GOODWIN, *Secretary,* University of Florida, Gainesville.

GEORGIA: **Georgia Section of the A. C. S.:** ANDREW M. FAIRLIE, *Chairman;* W. P. HEATH, *Secretary,* Coca Cola Company, Atlanta.

ILLINOIS: **Chicago Section of the A. C. S.:** W. V. EVANS, *Chairman;* W. M. HINMAN, *Secretary,* Box 803, Chicago.

Illinois Association of Chemistry Teachers: W. E. HARNISH, *Chairman;* S. ALETA MCEVOY, *Secretary,* High School, Rockford.

INDIANA: **Indiana Section of the A. C. S.:** WM. HIGBURG, *Chairman;* C. T. HARMAN, *Secretary,* 111 East 18th St., Indianapolis.

IOWA: **Ames Section of the A. C. S.:** J. A. WILKINSON, *Chairman;* H. A. WEBBER, *Secretary,* 2331 Donald St., Ames.

Iowa Section of the A. C. S.: H. L. OLIN, *Chairman;* W. G. EVERSOLE, *Secretary,* University of Iowa, Iowa City.

KANSAS: **Kansas City Section of the A. C. S.:** J. E. WILDISH, *Chairman;* PERCY F. BALFOUR, *Secretary,* 718 W. Waldo Ave., Independence, Missouri.

Kansas State College Section of the A. C. S.: H. W. BRUBAKER, *Chairman;* A. T. PERKINS, *Secretary,* Kansas State Teachers' College, Manhattan.

Wichita Section of the A. C. S.: JOHN M. MICHENER, *Chairman;* D. EMERY COLWELL, *Secretary,* 718 W. K. H. Bldg., Wichita.

KENTUCKY: **Kentucky Association of Chemistry Teachers:** V. F. PAYNE, *Chairman;* H. J. ROBERTSON, *Secretary,* Augusta Tilghman High School, Paducah.

LOUISIANA: **Louisiana Section of the A. C. S.:** W. O. GRIFFEN, *Chairman;* H. O'DONNELL, *Secretary,* Room 324, U. S. Customs House, New Orleans.

MAINE: (*See* **New England States**).

MARYLAND: **Maryland Section of the A. C. S.:** A. A. BACKHAUS, *Chairman;* W. C. MOORE, *Secretary,* Box No. 1103, Baltimore.

MASSACHUSETTS: (*See* **New England States**).

MICHIGAN: **Michigan College Chemistry Teachers' Association:** D. L. RANDALL, *Chairman;* A. B. DOW, *Secretary,* Junior College, Grand Rapids.

MINNESOTA: **Minnesota Section of the A. C. S.:** S. C. LUND, *Chairman;* R. E. KIRK, *Secretary,* University of Minnesota, Minneapolis.

MISSOURI: **Kansas City Section of the A. C. S.:** J. E. WILDISH, *Chairman;* PERCY F. BALFOUR, *Secretary,* 718 W. Waldo Ave., Independence.

St. Louis Section: C. F. CARRIER, *Chairman;* H. A. CARLTON, *Secretary,* Mallinckrodt Chemical Works, St. Louis.

University of Missouri Section of the A. C. S.: A. J. HOGAN, *Chairman;* L. D. HAIGH, *Secretary,* 1617 Cauthorn Ave., Columbia.

MONTANA: **Montana Section of the A. C. S.:** EDMUND BURK, *Chairman;* JESSIE RICHARDSON, *Secretary,* State College, Bozeman.

NEBRASKA: **Nebraska Section of the A. C. S.:** D. J. BROWN, *Chairman;* E. J. BOSCHULTE, *Secretary,* University of Nebraska, Lincoln.

NEVADA: **Science Division of the Nevada State Teachers' Institute:** G. W. SEARS, *Chairman;* E. C. STRENG, *Secretary,* 766 West Street, Reno.

NEW ENGLAND STATES: New England Association of Chemistry Teachers: J. S. CHAMBERLAIN, *Chairman;* OCTAVIA CHAPIN, *Secretary,* Malden High School, Malden, Massachusetts.
Central Division: F. R. BUTLER, *Chairman;* Worcester Polytechnic Institute, Worcester, Massachusetts.
Northern Division: LORNE F. LEA, *Chairman,* St. Paul's School, Concord, New Hampshire.
Southern Division: J. W. INCE, *Chairman,* Rhode Island State College, Kingston, Rhode Island.
Western Division: E. C. WEAVER, *Chairman,* Bulkley High School, Hartford, Connecticut.

NEW HAMPSHIRE: (*See* **New England States**).

NEW JERSEY: New Jersey Science Teachers' Association: ANNIE P. HUGHES, *Chairman;* PAUL D. TSCHUDY, *Secretary,* Senior High School, Atlantic City.

NEW MEXICO: Teachers' Association: J. D. CLARK, *Chairman,* State University of New Mexico, Albuquerque.

NEW YORK: Cornell Section of the A. C. S.: J. R. JOHNSON, *Chairman;* C. W. MASON, *Secretary,* Cornell University, Ithaca.
Eastern New York Section of the A. C. S.: C. G. HURD, *Chairman;* R. H. KIENLE, *Secretary,* General Electric Company, Schenectady.
New York City Section of the A. C. S.: R. R. HENSHAW, *Chairman;* S. P. BURKE, *Secretary,* 52 East 41st Street, New York City.
Rochester Section of the A. C. S.: E. M. BILLINGS, *Chairman;* H. W. CROUCH, *Secretary,* Building 14, Kodak Park, Rochester.
Syracuse Section of the A. C. S.: C. R. MCCROSKY, *Chairman;* NEAL A. ARTZ, *Secretary,* Bowne Hall, Syracuse University, Syracuse.
Western New York Section of the A. C. S.: R. B. MCMULLIN, *Chairman;* C. A. VINCENT-DAVISS, *Secretary,* Carborundum Company, Niagara Falls.

NORTH CAROLINA: North Carolina Section of the A. C. S.: F. K. CAMERON, *Chairman;* L. B. RHODES, *Secretary,* Department of Agriculture, Raleigh.

NORTH DAKOTA: Teachers' Association: E. S. REYNOLDS, *Chairman;* G. A. ABBOTT, *Secretary,* University of North Dakota, Grand Forks.

OHIO: Ohio State Chemistry Teachers' Association: M. V. MCGILL, *Chairman;* E. H. SHADE, *Secretary,* Harding High School, Marion.

OKLAHOMA: Oklahoma Section of the A. C. S.: H. M. TRIMBLE, *Chairman;* S. R. WOOD, *Secretary,* Agricultural and Mechanical College, Stillwater.

OREGON: Oregon Section of the A. C. S.: F. H. THURBER, *Chairman;* R. A. OSBORNE, *Secretary,* 227 South Seventh St., Corvallis.

PENNSYLVANIA: Central Pennsylvania Section of the A. C. S.: WALTER THOMAS, *Chairman;* H. O. TRIEBOLD, *Secretary,* Pennsylvania State College, State College.
Erie Section of the A. C. S.: C. H. REESE, *Chairman;* J. L. PARSONS, *Secretary,* Hammermill Paper Company, Erie.
Lehigh Valley Section of the A. C. S.: H. A. NEVILLE, *Chairman;* J. G. SMULL, *Secretary,* 66 W. Greenwich Street, Bethlehem.
Philadelphia Section of the A. C. S.: E. C. BERTOLET, *Chairman;* L. L. JENNE, *Secretary,* 825 City Hall Annex, Philadelphia.
Pittsburgh Section of the A. C. S.: F. E. MARBACHER, *Chairman;* ARTHUR SCHRODER, *Secretary,* 711 Forbes Street, Pittsburgh.

RHODE ISLAND: (*See* **New England States**).

SOUTH CAROLINA: South Carolina Section of the A. C. S.: C. A. HASKEN, *Chairman;* H. E. STURGEON, *Secretary,* Presbyterian College, Clinton.

SOUTH DAKOTA: South Dakota Education Association: R. O. DOTT, *Chairman;* RALPH E. DUNBAR, *Secretary,* Dakota Wesleyan University, Mitchell.

TEXAS: Central Texas Section of the A. C. S.: J. C. GODBEY, *Chairman;* G. S. FRAPS, *Secretary,* Agricultural and Mechanical College, College Station.

UTAH: Utah Section of the A. C. S.: A. M. GANDIN, *Chairman;* C. R. KINNEY, *Secretary,* 1430 East Thirteenth Street, Salt Lake City.

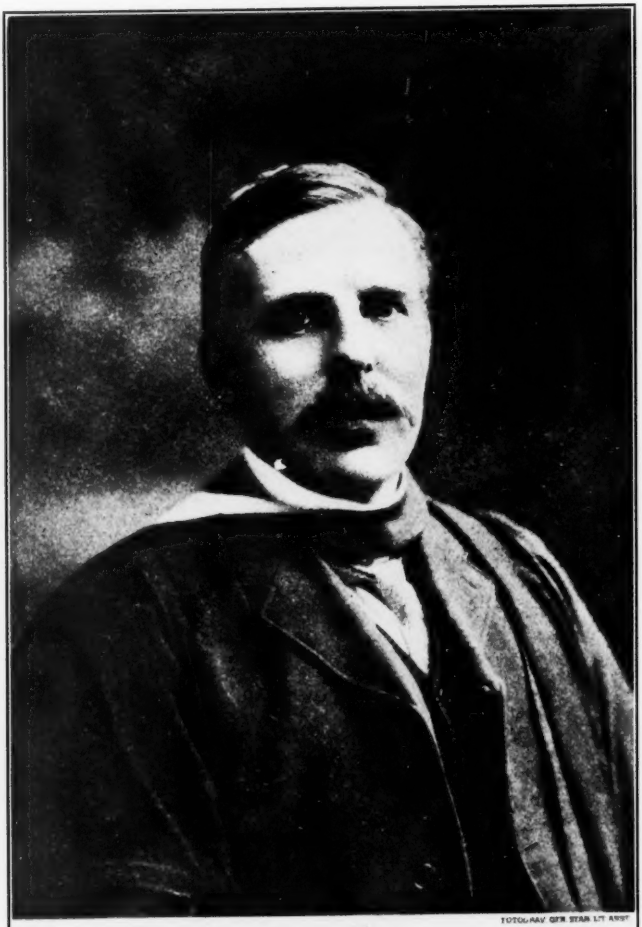
VERMONT: (*See* **New England States**).

VIRGINIA: Virginia Section of the A. C. S.: EDWIN COX, *Chairman;* BRAXTON VALENTINE, *Secretary,* Valentine Meat Juice Company, Richmond.

WASHINGTON: Washington State Association of Chemistry Teachers: H. E. GAINES, *Chairman;* V. L. CLARK, *Secretary,* Stadium High School, Tacoma.

WEST VIRGINIA: Teachers' Association: F. E. CLARK, *Chairman;* HERBERT MCMILLAN, *Secretary,* Morgantown.

WISCONSIN: Wisconsin Chemistry Teachers' Association: I. W. JOHNSON, *Chairman;* S. EDITH BROWN, *Secretary,* North Division High School, Milwaukee.



E. Rutherford

EDITOR'S OUTLOOK

THE discovery of the X-ray and the swell of unforeseen developments that followed it in a great wave and that have not yet lost their novelty in science, have served to convince more than one physicist that his own boundaries were too narrow and that the neighboring prospect of radioactivity might well be drawn within those boundaries. Fortunately for the two sciences involved, the new vista exercised its fascination on the young physicist, Ernest Rutherford, who, in 1895, when Becquerel, the Curies, and their associates were beginning their studies on the ray-emitting elements, was lately come to Cambridge to work as a research student under Sir Joseph Thomson.

Sir Ernest Rutherford 1871–

Rutherford had received his preliminary education in Nelson, New Zealand, where he was born, and had pursued graduate work at New Zealand University, from which he had received a master's degree with first-class honors. His studies there were occupied with the properties of iron and from them he developed a method for the magnetic detection of electrical waves which has since been applied by Marconi in radiotelegraphy.

On an 1851 Exhibition Science Scholarship Rutherford went to England and, while working at Cambridge, he became alive to the possibilities of the new field of science which was being opened across the Channel. He immediately set to work on the investigation of uranium emanations, and, when he left Cambridge in 1898 to accept the professorship of physics at McGill University, Montreal, his interest in radioactivity was already fixed. During the ensuing nine years in Canada, he succeeded in distinguishing the three principal types of radiation and he pursued also the study of induced activity, the phenomenon first observed by himself and the Curies working on different elements. From these researches, many of them in association with Frederick Soddy, another conspicuous worker in the field, came the natural blossoming of Rutherford's brilliant theory of spontaneous disintegration, which linked the previously isolated observations of many students of radioactivity, and gave a new strength to the abundance of recorded phenomena.

After his return to England in 1907 as professor of physics in the University of Manchester, he continued his investigations in the field which he had found so fertile, and, in the following year, he became the second of a noteworthy succession of physicists to carry off the Nobel prize in chemistry, awarded him "for his investigations into the disintegration of the elements, and the chemistry of radioactive substances."

Out of the work on disintegration, Rutherford subsequently developed ideas on atomic structure which formed the basis of the Bohr theory. Moreover, through his conviction that radioactive changes occur within the atom, he has constructed a system of alpha-ray bombardment which

has brought about a partial displacement of atoms in some substances. This transmutation of elements has received a limited confirmation in the experience of other recent investigators, and may yet serve as a latter-day alchemy which will lift the obloquy under which the medieval forerunners of the science of chemistry have found an uneasy resting-place.

Rutherford's remarkable successes have brought him new responsibilities with world-wide esteem. He has received many honorary degrees in the United States, which he visited in 1904 to give the Silliman Lectures at Yale University and courses at other institutions in this country. In 1923 he served as president of the British Association for the Advancement of Science and he is now the president of the Royal Society, which, as early as 1904, had recognized his achievements by conferring on him the Rumford Medal. He has been admitted by the King of England to the Order of Merit, a knighthood recognizing the aristocracy of intellect.

In 1919 Rutherford succeeded Thomson in the Chair of Experimental Physics at Cambridge, a post which he still occupies, and in the direction of the Cavendish Laboratory, in which the foundation of his own accomplishments was laid, he exercises the attraction of a forceful character overlaid with a frank and genial personality in the supervision of the activities of a large body of research students from all corners of the world.

The JOURNAL *gratefully acknowledges its indebtedness to Mr. Sederholm, managing director of Nobelstiftelsen, Stockholm, Sweden, for the accompanying photograph of Sir Ernest Rutherford, and to Dr. Frederick G. Donnan of University College, London, for portions of the information contained in this biographical sketch.*

A Gift and a Challenge

ONE of the significant characteristics of science is that it, more than any other form of human activity, can lay claim to cumulative results. In science, to a greater extent than in any other field of endeavor, is it true that we stand upon the shoulders of our predecessors. But what is true potentially can be made a practical actuality only if scientific work is recorded promptly and fully and if the records are completely and accurately indexed.

In chemistry, and no doubt in other sciences, the magnitude of the task involved in effecting a liaison between potentialities and the actuality has increased at a stupendous rate of late years. The *Journal of the American Chemical Society* has found its budget increasingly inadequate to keep pace with the research papers which it should record. Until

recently *Chemical Abstracts* was forced to abbreviate its items to the point where it threatened to become a mere index of titles and references.

Happily, the immediate exigencies of the situation have again been relieved through the generosity of Mr. Francis P. Garvan and The Chemical Foundation. The American Chemical Society has been enabled to add some $95,000 to its publication budget for the year 1930. This subsidy will permit the *Journal* of the Society and the *Analytical Edition* of *Industrial and Engineering Chemistry* to meet the demands laid upon them for the coming year. Its effects are already noticeable in the pages of *Chemical Abstracts*. Not only the Society but American chemistry and chemistry in general are again debtors to these benefactors.

It does not seem proper, however, nor should it be necessary, for the Society to depend upon annual gifts to maintain a permanent program, and especially a program of such magnitude and merit. Surely, as Dr. Howe has recently suggested, it should be possible to inform others who are seeking wise outlets for funds which they desire to devote to the public good of the importance of work of this kind and to induce them to contribute toward a permanent endowment. The Society already has the nucleus of an endowment fund to guarantee the life and effectiveness of its publications. Its members and friends could signify their appreciation of Mr. Garvan's past generosity in no more fitting manner than by making an active effort to increase that nucleus to significant proportions.

The Journal of Higher Education

THE first two numbers of the newly founded *Journal of Higher Education*[1] lie upon our desk. Having read them with some care and a great deal of interest, we arrive at the happy conclusion that the new publication shows every promise of being something more significant than another addition to an already populous class.

In the initial number Dr. W. W. Charters sets forth the editorial policies of the *Journal* in part as follows:

> The objectives of the *Journal of Higher Education* are more definite now than they may be later. Its columns are open for the discussion of problems of policy and administration. The editors are particularly interested, however, in the presentation of scientific studies through which instructional and administrative techniques may be evaluated with increasing exactness.
>
> The fields for which the *Journal* will serve as a medium are best described by the titles of the associate editors which are found on an early page of this issue. It will be noted that general education is represented by but a few men, but that the preponderating majority of editors is composed of men of recognized scholarship in their

[1] Issued by The Ohio State University Press.

chosen fields and professions who have demonstrated unusual interest in the scientific study of the problems of instruction and administration. When the list of editors is complete, it will include representation of the subject-matter fields in the colleges, of the major professional schools' junior colleges, and teachers' colleges.

Examination of the list of associate editors reveals that about one-third of the total twenty-eight are professors of education or heads of education departments. A few more are, no doubt, "education" men (or women) who have graduated to deanships or other administrative positions. On the whole, however, there seems to be a safe majority of men of recognized scholarship in fields other than education. Personally we feel that this is a wise arrangement. There can be no question that it is a politic one.

Of the twelve original articles contributed to the January and February issues, seven are either accounts of more or less quantitative studies or discussions based upon fact-finding investigations. These we shall not presume to criticize further than to say that they display a commendable restraint in drawing conclusions. The other five papers compare favorably with the essays on educational subjects which appear from time to time in the better type of lay periodical.

Following the original articles there is a section entitled "With the Technicians," in which well-written digests of current educational studies are presented. "The Reporter" is devoted to educational news exclusive of personal items. The accounts are concise, yet long enough to be truly informative and they show evidence of careful editing. The "Editorial Comments" are thoughtful and well expressed. Under "Reviews" are included discussions of recent books on education and related topics, and brief abstracts of articles in the lay magazines.

The general format is dignified—without undue exaggeration we might say distinguished—and the Caslon Old Face type is sightly and kind to the eyes.

The Probable Distribution of Leisure

MUCH philosophical, semi-philosophical, and pseudo-philosophical discussion and speculation are nowadays expended upon the apparent and probable sociological effects of applied science. The astounding prosperity of the United States since 1922, so conspicuous in a world oppressed by debt and discouraged by unemployment, has inspired many, both here and abroad, to dream dreams and see visions.

There have been numerous factors contributory to that prosperity and we shall not attempt to analyze them. One conspicuous feature, however, has been the application of science to the exploitation of vast material resources. That application has taken place through the inven-

tion of chemical and physical processes, through the invention and use of labor-saving machinery, and through the development of sources of power. Power, scientifically produced and scientifically applied, is doing an enormous share of the world's work, and particularly of America's work. Apparently the present trend is toward the use of more and more power and toward the invention of more and more ingenious methods of automatic or semi-automatic control for that power.

Consequently, some thinkers look forward to the time when we shall be able to satisfy all our needs through the expenditure of four or two or even less hours a day of labor. They raise the question as to what shall be done with the leisure thus made available to us. Some are even agitated about the probable effects of so much free time upon the masses.

We wish here to extend a word of cheer and comfort to any who may have spent sleepless nights in the contemplation of these disquieting problems. In the first place it is not at all indicated by the present trend of events that increased individual productivity is going to be immediately or largely reflected in increased leisure for society. Human wants refuse to remain static. While applied science has been increasing individual productivity, it has also been creating new products and stimulating new wants. Few workmen, even if given the choice, would elect, say, a four-day working week and the necessities of life in preference to a five-day working week with necessities plus an automobile, a radio, etc. In most cases they are not likely to be given the choice.

In the second place it is not evident that the potential leisure available to society at large is going to be distributed pro rata to individuals in the form of so many hours of free time per day. At the present time we see much of this potential leisure absorbed in longer periods of education for the younger generation. We see it absorbed in the transfer of individuals from full-time production of physical essentials to full-time activity in other fields—luxury production, school teaching, scientific research, the arts, etc. All present indications are that we shall not be faced with the problem of teaching the average man to employ any great amount of leisure profitably, but that we shall train and support more and more individuals for full-time work in activities which were once considered leisure occupations.

THE DIALYZER

(*For questions* 1-4 *see* pp. 499–517.)

1. What three birthday commemorations of special interest to agricultural chemists occurred in 1928?
2. Would you like to read a student's estimate of three well-known European chemists of the last century—Erdmann, Liebig, and Wöhler?
3. Where is the Lawes Testimonial Laboratory?
4. Are you interested in early agricultural investigations?
5. Is the act of seeing a photochemical process? Explain. (pp. 518–29.)
6. Have you seriously considered the problem of selecting the chemist? (pp. 530–41.)
7. What part did Elijah Paddock Harris have in shaping chemistry instruction at Amherst? (pp. 542–55.)
8. What literature is available to aid the chemist in preparing and functioning as an expert witness? (pp. 556–61.)
9. Have radio programs on chemistry been successful? (pp. 562–4.)

(*For questions* 10–12 *see* pp. 571–86.)

10. Should laboratory or recitation have precedence in the teaching of high-school chemistry?
11. Are you familiar with the published reports of several investigators of this question?
12. For the study of the calcium unit, is your outline satisfactory? Are you interested in specimens of (1) immediate and (2) delayed recall tests on the calcium family?
13. Do you wish to demonstrate to the class the influence of a solvent on the speed of a reaction? (pp. 589–90.)
14. Does a straightforward method of solving equilibrium problems interest you? (pp. 591–3.)
15. Would a classification of aldol and related condensations be of any use? (pp. 597–609.)
16. To what new use has cellulose recently been put? (p. 617.)
17. Have you had difficulty in removing a melt from a crucible? (pp. 622–3.)

(*For questions* 18–19 *see* pp. 633–6.)

18. Irritating fumes from wax candles stimulated what chemist to the investigation of what well-known chemical reaction?
19. What famous chemist used the *nom de plume* of S.C.H.Windler in a letter ridiculing the claims of a fellow-chemist for his "theory of types"?
20. Do you know the game of chemists? (p. 636.)
21. How is carbon dioxide made commercially? How purified? (pp. 637–52.)
22. Are you familiar with the story of the origin and the derivation of the word chemistry? (p. 652.)
23. And would an evening of explosives entertain you? (pp. 653–9.)
24. Have you assigned the "chlorox" problem to your class? (pp. 672–3.)
25. Could you use a freezing mixture which produces a temperature drop of 31°? (p. 686.)
26. How is the University of Vermont solving its problem of teaching a fundamental course in chemistry to students of varying degrees of ability? (p. 717.)

EUROPEAN LABORATORY EXPERIENCES OF AN EARLY AMERICAN AGRICULTURAL CHEMIST—DR. EVAN PUGH (1828-1864)*

C. A. BROWNE, U. S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

The year 1928, in addition to its being the one hundredth anniversary of the synthesis of urea, had three birthday commemorations which are of more special interest to agricultural chemists. These were the two hundredth anniversary of the birth of Dr. Joseph Black, distinguished for his researches upon carbon dioxide, the one hundred and fiftieth anniversary of the birth of Sir Humphry Davy whose treatise upon "Agricultural Chemistry" was for many years the leading work of its kind, and the one hundredth anniversary of the birth of Dr. Evan Pugh, who is best known for his researches upon the fixation of atmospheric nitrogen by plants.

Dr. Pugh's death in 1864 at the early age of thirty-six, during his presidency of the Pennsylvania Agricultural College, now Pennsylvania State College, removed one of the most brilliant investigators in the field of agricultural chemistry. It is doubtful if any American chemist ever prepared himself so thoroughly for his future career as did young Pugh in the six years between 1853 and 1859 when he was occupied in studying chemistry at various institutions in Germany, France, and England. It is also probably true that no American chemist has left a more complete record of his chemical activities in foreign lands than is found in the correspondence of Pugh. His letters to friends and to newspapers give a most complete and fascinating picture of the teaching and practice of chemistry in European countries according to the methods of seventy years ago. The personalities of the famous chemists whom Pugh met in his travels are also portrayed most vividly so that we seem to have before us breathing likenesses of the men. Through the kindness of Mrs. Henry Clay Valentine, of Bellefonte, Pennsylvania, whose husband was a brother of Mrs. Pugh, and of Professor E. W. Runkle, Historian of the Pennsylvania State College and a biographer of Dr. Pugh, I have been permitted to look over much of this correspondence. I will not enter into any details of Dr. Pugh's career, which has been sketched in a most charming manner by Professor Runkle in his address before the Pennsylvania State College Section of the American Chemical Society on February 29, 1928,[1] the centennial anniversary of Pugh's birth. What follows is simply the story in Pugh's own words, as abstracted from his correspondence, of some of the things which he observed and considered during his years of chemical study in foreign countries.

Leipsic, 10th mo. 31st, 1853.

MR. EDITOR:

Having found comfortable quarters in this inland town, where I shall remain for

* Read before the History of Chemistry Division at the 76th Meeting of the A. C. S., Swampscott, Mass., Sept. 11, 1928.

[1] "The Pugh Centenary," Erwin W. Runkle, The Penn State Alumni News, March, 1928, 3–12.

some time, I will make some remarks on what I have seen in it, during the two weeks that have elapsed since I arrived.

Though I failed to meet a young gentleman from Philadelphia, whom I expected to meet, I found a letter in the post-office from him to me. On inquiring for it, I was required to show my passport before I could get it. This I had not with me but the thoughts of getting a letter soon actuated me to get it where I had left it at the tavern.

The letter gave me an introduction to a young man of the name of Johnson, who was formerly a student in the chemical department at Yale College, and who is now here, completing his studies in that science. He is, what is very rare here in Germany, and what I feared from various reports I would not be able to find, a *strictly temperate student*, as regards the use of tobacco and intoxicating drinks, such as wine, lager beer, tea, coffee, etc., and I am very willing to lose the honor of being the *only* temperate student amongst 900 or 1000, for the pleasure of enjoying his society during the six months that we shall be together.

The next day after my arrival was spent in looking around the town, and on the following morning we (Johnson and I) visited the University buildings. They are very large, occupying a large block, under which several narrow streets pass. They present rather an antiquated appearance in some places on the outside, but I saw none of this in the inside.

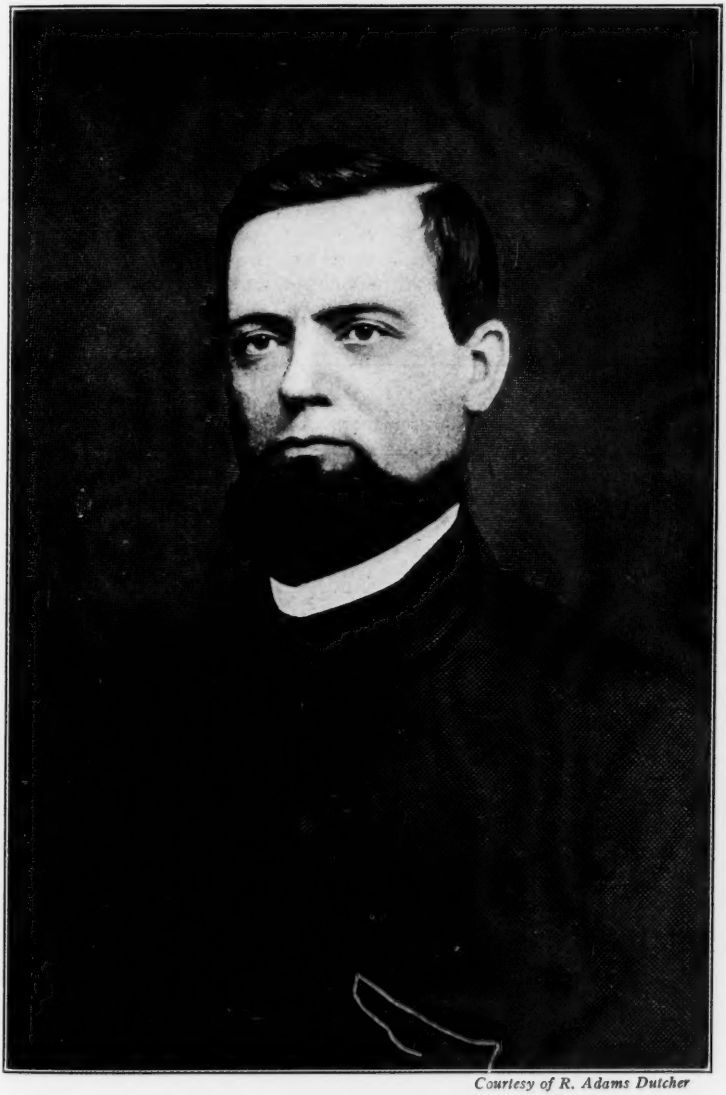
The object of our visit was to see Professor Erdmann, under whose superintendence the chemical department is conducted. It was then vacation, and he was not engaged with students.

Professor Erdmann, though not generally known in America, stands high as a chemist in Europe. He is the author of several books on chemistry, besides being an assistant editor of a chemical paper (a thing America has not yet supported) which is of a strictly scientific character. We found him in his library. He turned from his books to welcome us, with a familiar affability that was well calculated to make the stranger feel at home. He speaks English a little, and although our intercourse with him was through our little German and his little English combined, yet I saw enough to convince me that he was a whole-souled man, who could throw aside formal dignity, which is oppressive by its presence, and without fear of losing any of the real dignity of his standing as a man of science, could enter into friendly chat, introducing the enlivening anecdote, and laughing over its peculiar phases.

He is a rather large man, with a fully developed chest, and a healthy appearance; with an expressive countenance which becomes quite animated in conversation. His phrenological appearance bespeaks a man of a well-developed practical intellect. I shall speak of him as a lecturer hereafter.

His room was small, but well supplied with books and papers, and around on the walls were hanging the portraits of distinguished men of science; a sofa, a few chairs, and a table made up the ordinary furniture. He introduced us into an adjoining room, of about equal dimensions, where he carries on his own experiments. No German teacher contents himself with merely attending to his classes, and sitting down at ease after he has got them at work. He is studying constantly himself; making original investigations and publishing them to the world.

His little laboratory is well supplied with the best of apparatus, much of which, that has been adopted by chemists generally, he contrived himself. Passing through this room we entered the students' laboratory. This was large enough to accommodate sixteen or twenty students, giving each an experimenting table and a set of reagents. It is very comfortably arranged, and so situated as to give a fine view into an open square, and receiving the rays of the morning sun; contrasting in this respect finely with many



Courtesy of R. Adams Dutcher

EVAN PUGH

Born of Welsh Quaker parentage, the son of a Pennsylvania farmer-blacksmith, Pugh received his early training in the states of Pennsylvania and New York. The foreign period of his education is described in the accompanying article. On his return to the United States in 1859, he was made president of the Farmer's High School, which became under his administration The Agricultural College of Pennsylvania (now the Pennsylvania State College). Broadly outlined administrative plans and activities in the interest of his college and of the future of agriculture crowded the remaining years of his life, which ended at the age of 36 years on April 29, 1864.

of our American laboratories, which for want of their merited patronage, are crowded off into unpleasant parts of the towns, where rents are not so high.

In another room were the materials for making poisonous and unpleasant gases, some of which are required at almost every step in chemical analysis. Adjoining this was the lecture room, which is capable of seating fifty students, and by an ingenious contrivance doors can be thrown open, so as to allow the lecturer to use the furnace and heating apparatus in one room, to make illustrations before the students in the lecture room. After selecting a work-bench, where I thought I should like to perform a few experiments during the coming winter, we left the University buildings, thinking we could look over them at some other time. I was remarkably fortunate in arriving four days before the course of lectures opened for the winter, as it gave an opportunity to make some selection of a place.

* * * *

Munich, 8th mo. 24th, 1854.

MR. EDITOR:

The weather is fine, the walks and groves are fresh and enlivening, all nature smiles, but man quails in terror and the cholera still rages. The dead carts with their black covering and large cross are constantly seen in the streets. The people are recovering a little from the terror of the commencement of the week....

Yesterday I visited the chemical laboratory of the world-renowned Professor Liebig; he also was in bed with the cholera. His house, laboratory, etc., are all under adjoining roofs. They are surrounded by gardens and present quite a pleasant appearance. His lecture room is large, capable of holding comfortably 200 students.

It would exhaust too much of your space to give the minutiae of the lecture room. It is enough to say *everything was complete*, convenient, and of the very best kind. A vast amount of apparatus that the student of chemistry would at first glance recognize as the invention of the Professor himself. The students' laboratory is small, only adapted to admitting seven students. He has almost entirely withdrawn himself from the drudgery of giving instruction in analytical chemistry. He expressly informs a student in this branch of science, who proposes coming here, that he *does not obligate himself in any manner whatever* to give the *least* attention to them or to *interest himself* in their investigations, and will inform them it is better that they go to some other place.

A student informed me that when he first came, Liebig told him he had better go away; but he was determined not to go as he desired the credit of being here if he did not get the worth of it, and he felt well assured that the Professor could not well avoid coming into the laboratory sometimes and interesting himself with subjects by the investigation of which he has arisen to his present position of fame.

He did not regret coming, and when the Professor found he was going away, he insisted on his staying longer.

Advanced students in analytical chemistry require very little assistance from professors. They should not trouble them for the details of any information that is correctly given in the books—a short consultation once or twice a week would be amply sufficient in most of cases; whereas the beginner wants almost constant attention of that kind which no man as deep in science as Liebig would want to give. Hence he uses such language to those who propose coming here as will, together with his high charge (double the ordinary), prevent any but advanced students from coming, and give no cause for these to be disappointed if he should not feel interested in them or the subjects they choose for investigation. Finally he has attained the highest possible position attainable for a teacher; as such, he can lecture on such subjects as are most interesting to himself, can direct the investigations of the most advanced students the world produces into such channels as he is particularly interested in, that they may

get his counsel—can give his counsel with a consciousness, both on his own part and that of the students, that he does it not because he is obliged to do so. He can neglect them for two or three weeks at a time if he wishes to take a pleasure trip, even taking the time of his lectures that are attended by over one hundred students, etc., etc.

And all this and yet the student determined to remain with him:

Aside from the *name* there are probably better teachers of chemistry in Germany than Professor Liebig; as a lecturer the same remarks are perhaps not applicable.

In Göttingen Professor Wöhler is a most assiduous teacher, takes a *constant, deep interest* in all his students, and devotes his entire time and interest to their promotion, and as a chemist is thought to be not much inferior to Liebig. But all object to his laboratory, it is so crowded with students. Yet all of these are his enthusiastic admirers and are well satisfied with their opportunities.

I merely notice the latter professor as a contrast with Liebig. But at almost any of the universities here the student can find amply good instructions in chemistry if he has only three or four years to embrace them. I need only say that I will shortly enter my *third* half year in Leipsic, whereas my original intention was only to remain there six months, to let my friends know what I think of the opportunities of that place.

In conclusion with respect to Liebig, I would say that as a man he is not remarkably sociable; appears rather aristocratic on first acquaintance, is more the *scholar*, the *thinker*, and investigator, than the free, easy, sociable friend. Yet in his own family he manifests all the good qualities of a husband and father, and the stranger who meets him in this circle will find a different man from that he presents when surrounded by the objects of his investigations.

He has in family three daughters, the eldest married to a professor here. She has a family. The second daughter is engaged to Professor Hoffman, of England, one of the greatest chemists in the world, and the third is a pretty little girl of twelve. He has one boy of 14. ... A pleasant family and he is happy with it.

* * * *

MY DEAR JOHNSON: Leipsic, 12th mo. 1st, 1854.

....

I have not heard Erdmann this semester, indeed I have hardly seen him. He is very little in the laboratory now. He was elected Rector last vacation and this office occupies so much of his time that his services in the laboratory are just about 0. Wunder (who by the way has moved out into the West Strasse and is one of my nearest neighbors) complains that Prof. is not enough in the laboratory. I do not want to see the Prof. or to have his advice more than once in two or three days but to not get it once a week is rather too rare. Last semester I had busied myself with mass analysis, soil analysis, guano analysis, and coal analysis, all of which were sent here for analysis. This semester I told the Professor I would like to have something to work over that would require some study and reading and not all work as what I had been at had required. He said he had a subject already prepared for me. That was the *Hämatinsalpetersäure* and its salts and that I must prepare my picric acid from stone coal tar oil. And if I have not had one *divil* of a time with *Steinkohltheroil* I don't know what such a time is.

* * * *

Göttingen, July 23, 1855.

MY DEAR JOHNSON:

I feel like scolding you for not writing a longer letter, and I had been feeling like scolding you for some time past, for not writing at all. But I am happy to hear that you are still "alive and kicking." I have been about 4 months in this little old town. The natural scenery around here is far more interesting than around Leipsic and with the

company of some 14 Americans here the times go light and lively. I look back on my last year in Leipsic spent without friends and almost without associates, as rather dark and gloomy compared with the jolly present. There are 8 Americans in the laboratory now and we are nearly all in one room from which we have excluded the Germans entirely. The opportunities for an advanced student of chemistry in Leipsic bear no comparison to what they are here. I was told at Leipsic that at Göttingen I would have to "find *alles*"—alcohol, evaporating dishes, etc., etc., and that the lab. found nothing. Nothing could be farther from the truth. With regard to finding things here the arrangement is 10-fold better for the student than in Leipsic. The lab. is not quite so well supplied with apparatus down in the cellar but all that there is, is at your service and you can go and take it without asking for it. If you break it *by carelessness* you must pay $^1/_3$ its value, if you break it by an unforeseen or "*unerwartet*" explosion *oder "so wass"* you *pay nothing*. They trust to your honor to show what you break to have it recorded against you. If you can't find anything to do *anything you may want to do that ever has been done* or that requires apparatus similar to that used for doing anything that ever has been done, you can get it by asking either of the assistants for it. You will not have to wait an hour or two, but it comes immediately. You can't imagine what a difference there is between here and Leipsic in this respect. For instance, an American student here wants to make aluminum. Prof. has ordered the apparatus *new*, because the old furnaces for that purpose are worn out.

As for myself I am putting propion through the same course that aceton has been "drubed" through and by using small quantities of propion I find it gives chlorine derivatives with much greater sp. gr. and boiling points than the propion itself. Prof. thinks the thing worth investigating and has placed a large quantity of *Butteressigsäures Kalk* at my disposal to get my propion from....

I had an explosion one day while Prof. was lecturing. It was a loud one and the Prof. quit instantly, and came to see what it was. A residue containing organic matter with cyanogen and saltpeter and copper was set into the sand bath to evaporate to save the copper. I had no thoughts of its exploding but it did and broke all the sand bath glass. The Prof. said I should not pay for one of them as, said he, the "explosion was not to have been expected; it could have happened to me just as easily as to you and such things the Lab. must pay for, etc., etc." This will give you an idea of two points. Another 3rd point is the ease with which you can get substances to experiment upon. If for instance you are reading about any branch of organic chemistry you can get the material of which that branch treats to work upon by asking for it. There are fellows here working upon the vegetable alkaloids, using large quantities of raw material, etc., but all supplied by the Lab. 4th, The opportunities here of seeing work done; I feel confident there is not a Lab. on this side the ocean where more work, *original work* or at least work on rare organic and inorganic substances is done than just here. The students, about 28 in number, are all advanced and they all work late and early. 5th, and lastly, Prof. Wöhler is a most splendid man to suggest courses that will probably lead to results, etc., etc., when one is making an investigation. In view of all these things I need hardly inform you that I am well satisfied that I came here but I had not been here six weeks till I made up my mind how long I would stay here. I expect to leave next spring for Heidelberg where I shall study gas analysis with Bunsen.

* * * *

MR. EDITOR: Göttingen.

....

Few places in Germany offer better faculties for studying mathematics and the physical sciences than Göttingen; and there are not so many objects here to divert the mind from study as there is at other universities.

WÖHLER AND HIS ADVANCED STUDENTS, 1856

The second standing figure from the left is Evan Pugh. Wöhler is the fifth from the left in the first row.

It is almost proverbial that if a student comes to Göttingen he comes to study, but if he goes to Berlin, he goes to have a "good time"—that is, to run about to the theatre, the opera, the dancing saloon, etc., at night and sleep during the day.

As for myself, the principal part of my time has been devoted to analytical and organic chemistry in Prof. Wöhler's laboratory. To no man living does the science of chemistry owe as much for the facts it embraces as to Prof. Wöhler, and no man has a higher reputation amongst the students of chemical science than he. When one reads his chemical works, and sees the immense labors that this man has performed, he is surprised to find it possible that so much can be done by one man in the ordinary period of life.

As a teacher he is unsurpassed—his only fault (if any he has) is that he teaches too much. His great good nature allows the students to crowd around him on his entering the laboratory, to ask a score of questions such as they should be able to answer themselves, did they study as every student should study.

Almost his entire time during the day is at the service of his students; and he seems to take the deepest interest in what all are doing; and to see him going about amongst them with his old coat and little cap on, one would take him for almost any one but a professor.

A more unostentatious man, one never met; but his simplicity of manners does not surpass the goodness of his heart, and while we admire as the profound investigator in

science, it is pleasant to contemplate him as the social man. To look at him as the husband and father—to see his little girl of twelve summers take him by the hand and playfully lead him away from his crowded lecture room after his lecture is over.

As a scientific man I think his students would agree with me in saying, he does not owe his celebrity to long continued deep study. His labors have not been such as require the effort of the mathematician or the physical philosopher. His is not the order of mind that we see in a Newton or a Gauss, but his success is due to his towering genius—that which, as if by inspiration, penetrates the secret depths of nature's hidden mysteries, and illuminated by the vivid coruscations of its own activity sees clearly new relations between cause and effect, and brings them out into that sphere in which common minds move. He is a great chemist in the strictest sense of the word. Well did Herschell say that a clever man shut up alone might reason out all the truths of mathematics, but could not by any process of reasoning tell what would be the effect of putting a lump of sugar in water.

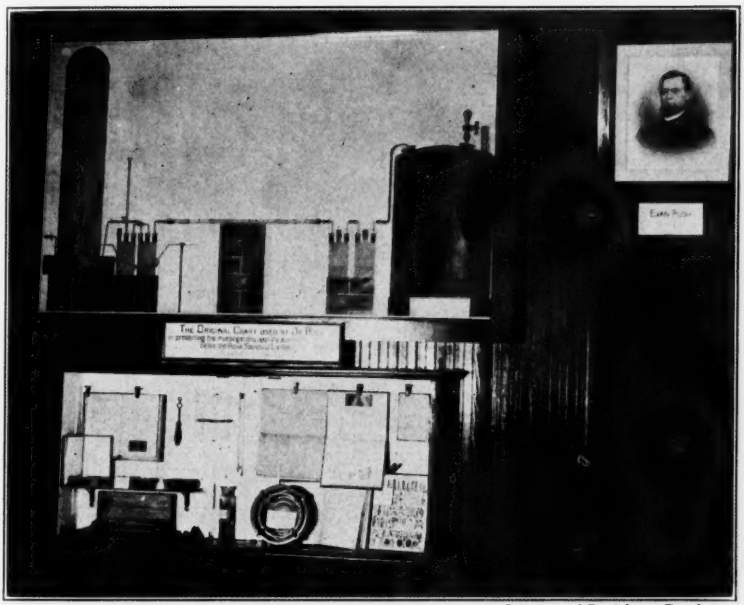
Experiment must begin here and suggestive genius must control that experiment, rather than calculating reason. An active mind may suggest a thousand experiments that no course of reasoning would ever lead us to; and each experiment may open fields for new suggestions, all of which present themes for the action of genius (of inspiration) rather than reason. A more suggestive mind than that of Prof. Wöhler is hard to conceive of. When the student is standing upon the outposts of science, and is fingering his way into the unknown and uninvestigated forces that govern the action of matter, he finds himself in a thousand dilemmas, from which to extricate himself he may crack his brain in vain. But here "the *Hofrath*" at his elbow, a score of suggestions as to what results certain processes will lead to, puts the student on his feet again, and he progresses forward.

It is true we cannot tell positively what will be the result of an experiment in chemistry before it is performed, yet a thousand little real or supposed analogies may lead us to a philosophical method of experimenting, so that no experiment need ever be performed without the experimentator having some definite object in view, and some definite result in anticipation. Slopping fluids from one vessel to another to look at phenomena merely is one thing, and philosophical experimenting is quite another. It is characteristic of Prof. Wöhler that he will not experiment without some definite object in view; and a score of times a day will he say, just as he is about to try an experiment, "we will assume the unknown solution to contain so and so, if we are right, this reagent must produce such and such results." He tries the experiment—if a negative result follows, another assumption from the vivid flashings of his mind opens the road for a new experiment, till at last old nature yields up her hidden secret and it becomes a fixed fact in science. But perhaps we have dealt sufficiently on a subject that can only be fully appreciated by the student of organic chemistry.

Whatever may be said in eulogy of our Göttingen professor of chemistry, we cannot say much in praise of our Göttingen Laboratory. I do not believe that there is another professor in the world who could get half a dozen students to work in such a dirty place, with its ten thousand disagreeable odors. Everything permeable to gases is saturated with their peculiar odors, and sometimes the students become so affluviated with their disgusting smell that they are recognized wherever they go, as having been in that old laboratory of *Hofrath* Wöhler.

But with old laboratory and all, so great is the number of applicants for admission that it is not possible to secure a place without engaging it three months beforehand; and great numbers who apply every term cannot be taken, and all are glad they come here, after coming.

* * * *



Courtesy of R. Adams Dutcher

COLLECTION OF APPARATUS USED BY PUGH IN HIS INVESTIGATIONS UPON THE ASSIMILATION OF NITROGEN AT ROTHAMSTED EXPERIMENT STATION

Göttingen, Nov. 15, 1855.

MY DEAR JOHNSON:

. . . .

I told the old man Wöhler the other day that I wanted to pass *an examination*—I could not afford to go away till I got my degree *in absentia*—so that if I fall through it will be my own fault for risking an examination. I will pass examinations in chemistry and physics. Prof. was perfectly satisfied that I do it, though it is not generally done here by Americans. The way that is generally done is to go off somewhere and send a petition back informing the faculty *that circumstances are such that you can't be in Göttingen at the examination and beg them to give you D.Ph. etc.*, then you can make circumstances allow you to go where you please—but after all I reckon the examination isn't much—I shall be very busy till the evening after my examination which will be in about 4 months from this time.

* * * *

Berlin, Jan. 10th, 1856.

MY DEAR EDITOR:

I have just finished a day in this town of curiosities. . . .

At 9 o'clock I called upon Prof. Magnus, to give him some things Prof. Walker had sent to him. Magnus is a young professor, though he is rapidly paving the way to eminence in his profession (physics). He was not at home and I went directly to Prof. Mitscherlich. I saw his assistant, who informed me that the Professor had to give a

lecture at 11 o'clock and it would be more agreeable to have an interview afterwards. Knowing that just before his lecture is the worst time in the world to speak with a professor, I willingly consented to adjourn my interview. The assistant however, showed me the particulars of his laboratory and lecture room. He takes no students in his laboratory, and it was nearly full of the apparatus for his lectures. Knowing as I did the great scientific reputation that Prof. Mitscherlich enjoys, for his investigations, that have more of a *theoretical* than a *practical* bearing, I was surprised to find his apparatus of such technical character; models of machines for washing potatoes, beets, etc., were amongst them in strong intermixture with electrifying machines and galvanic batteries, etc.

I soon left to visit Prof. Rose, the greatest analytical chemist in the world. I found him in his lecture room with his assistant, very busy getting ready for lecture. He is a fine large and well-proportioned healthy looking man, with broad face, high forehead and very pleasant looks.

He was very glad to hear that his old friend Wöhler was getting along finely in a new method he has lately discovered of silicium. Knowing that he had no time to talk, I told him I would not interrupt him more at present. He acknowledged that he was busy, but said that between 3 and 4 he was at leisure. But if I would engage to meet him at the academy of sciences, he would introduce me to some of their members. Such an offer was not to be refused, though it was more than I had any right to expect from him.

At 11 o'clock I was seated in the lecture room of Prof. Mitscherlich. The room is large, and all along one side of it are hung the portraits of distinguished chemists and natural philosophers. In the middle of the group, was the instructor of Mitscherlich, the immortal Berzelius. Among them the familiar, smiling face of my own Leipsic instructor, Erdmann, and the keen discerning countenance of our much-beloved Wöhler.

Presently Professor Mitscherlich appeared; I was surprised to see a man who had immortalized his name by an investigation nearly 40 years ago, look so very young, healthy, and vigorous. Many a man of 40 looks older. He is a large, rather fleshy man with full face, though it wears an intellectual cast of high order. He reminds me of Professor Erdmann in many respects; partly perhaps in having his attendant stand by to rub out his chalk marks as he got done using them on the blackboard. His subject was that of lactic, gallic, and tannic acids. It was eminently practical. "Tannic acid formed insoluble compounds with animal gelatin, gelatin was in the skins of animals; these macerated in tannic acid, took up the acid and it combined with the glue (gelatin) and formed leather. It formed black compounds with salt, of peroxyde of iron—the best inks were not black till after they had been written for some time and the peroxyde of iron in them oxydizes. It gave to green apples and to barks in general that peculiar stringent taste which is caused by a contraction of the vessels of the mouth.

"Tea contained a large quantity of a peculiar tannic acid, and the action of this upon the intestinal canal was such as would be highly beneficial in certain diseased states of the system, *but in a healthy system the action was to produce disease.*"—Tea had other properties due to substances that he would not now speak of.

At the close of his lecture I went up and spoke to him. He received me very friendly, and invited me up to his room to talk. He led me through his immense library, into his richly furnished study room and bade me be seated on the sofa. I informed him that it was with unspeakable pleasure that I had the honor of speaking with the discoverer of the law of isomorphism in his own study. A flush passed over his free open countenance as he remarked that his large class prevented him from devoting much time now to those purely scientific investigations. I saw that his class ranked amongst the largest that I had seen at any of the lectures I had attended. "But," says he, "it is generally considerable larger than just now, as I most always lose a good many students

Courtesy of Rothamsted Experiment Station

THE LAWES TESTIMONIAL LABORATORY

Reproduction of an old drawing showing the laboratory as it appeared when Pugh worked in it.

when I come to those vegetable acids—they are not interesting to any but purely chemical students and many of mine are medical."

* * * *

Paris, Jan. 15, 1857.

DEAR MR. EDITOR:

One does not find by any means that the men who have the greatest reputation out of France are the most popular in the lecture room. Boussingault of great reputation as an agricultural chemist has but a small audience.

Payen of equal reputation as a technological chemist is the most happy lecturer that I ever heard; where experiments are to be performed, he and his first assistant act in concert as though the same mind impelled them both to action and the three sub-assistants act no less finely in harmony with them. The professor talks and they experiment and no word is exchanged between him and them.... His audience amounts to three or four hundred.

* * * *

Harpenden Herts, Aug. 2nd, '57.

MY DEAR JOHNSON:

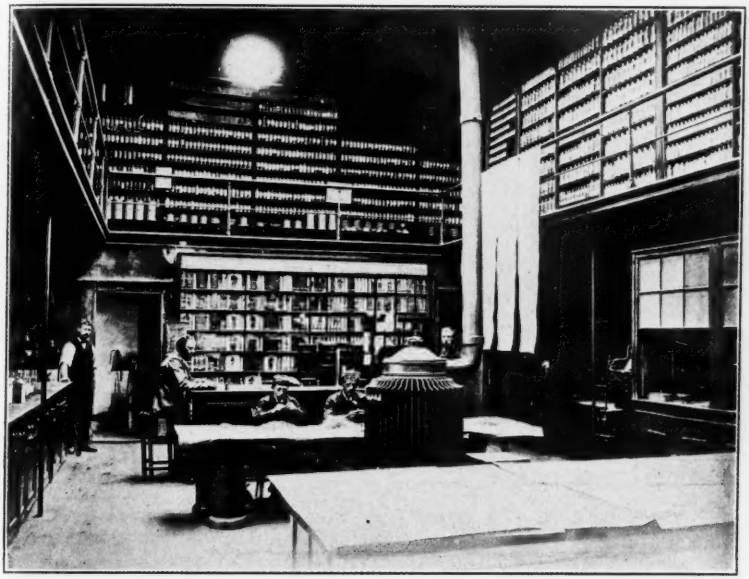
The contemplation of a train of past events carried my mind back this morning to the time that I broke in upon your meditations for the first time at No. 1678 West Strasse, Leipsic, and under the inspiration of the thoughts it suggested I have seated myself to embrace the last opportunity of sending you a line from this side of the immortal Duck Pond. I've nearly closed up my European course. It has been a pretty good one. $1^1/_2$ years in Leipsic, 1 year in Göttingen, $^1/_2$ year in Heidelberg, $^1/_2$ year in Switzerland and France, $^1/_2$ year in England; in less than a month it will be 4 years since I left home and in less than 2 months I hope to be on the ocean on my way back.

In looking back over the past I must say that for pure chemistry Göttingen is the place of places, for physical chemistry for an advanced student Heidelberg has not its equal but a chemist who has worked only in that Lab. would be a one-sided chemist indeed. In France (Paris) I spent my time hearing a great variety of lectures as chemistry, nat. philosophy, technology, agriculture, mechanics, mathematics, &c. &c, merely to get a general idea of the modes of instruction. My conclusion is that Paris is a poor place for the study of chemistry but excellent for such physical sciences as are developed with the aid of mathematical investigation.

I would advise a chemical student to go first to Wiesbaden or Giessen where he would get good lab. instruction and poor lectures (while he couldn't understand them), then go to Wöhler and get excellent lectures embracing principles easily understood, and good *process* instruction in the lab. and finally close with Bunsen for physical chemistry in the lab. and the most *profound* and *philosophical* lectures to be heard in chemical science in Germany.

With no part of my course am I better pleased than with that upon this Anglo-Saxon sand heap. But as you are a student of Liebig it would hardly be safe to say much in favor of this antipodal climate. I think when I wrote to you on the subject of the Liebig—Lawes & Gilbert controversy from Leipsic I remarked that I thought Liebig a very unfair debater. Since then I have gone through the whole controversy commencing with the 1847 translation of Liebig's book and ending with the last production of Liebig in which he quotes that remarkable declaration of Prof. Miller of Kings College "that the primary incentive to Mr. Lawes' investigations was a spiteful feeling toward Liebig for putting out a book which prevented him from monopolizing the manufacture of superphosphate."

This is no small charge, Johnson, and when I first read it I said that either Mr. Lawes



Courtesy of Rothamsted Experiment Station

INTERIOR AND EXTERIOR VIEWS OF THE ROTHAMSTEAD TESTIMONIAL LABORATORY DURING THE PERIOD OF PUGH'S INVESTIGATIONS THERE

was a very dishonest man or he had been libeled to such a degree as one would not expect in the limits of barroom slang much less in a scientific discussion between men claiming to be gentlemen. I have only to say that so far as Prof. Miller's own words *in private* can be relied on (and I am fully prepared to rely on them) he never made any such declaration. In dismissing this unpleasant question allow me to say that I have not changed my Leipsic opinion as to the fairness of the discussion.

You will see at the head of my letter a picture of my present laboratory. It was built at a cost of 1000£ by the farmers of England as a testimonial to Mr. Lawes. They gave him his choice, a *Laboratory* or its value of *Plate*. His choice speaks for the man quite as much as do *libelous* statements about his *motives*, and he now expends from 1000 to 1500£ a year in making investigations that have no more bearing upon his superphosphate manure than they have upon a mountain in the moon.

There are perhaps people who, incapable of a generous act themselves, might find a mercenary motive in his sustaining a school at his own expense for 200 poor children in London, or for his offering the cottagers of this village 600£ to improve their cottages with so soon as they raised $^1/_2$ that sum, or for his building them a library to try and elevate the condition of the laboring men.... I wrote to Dr. Gilbert while in Paris to know if they would supply me with apparatus to make an investigation on the Boussingault and Ville nitrogen question. The result was that I am here. They have supplied me with about $500 worth of apparatus and we have been doing up the subject on a scale unprecedented. I have 12 glass shades $3^1/_2$ ft. high and $9^1/_2$ inches in diameter and under them entirely isolated from the air we are growing plants and forcing NH_3-free air into them daily. Day before yesterday we had a visit from Prof. Graham, Noad (author of analysis), Bolard (French) and 5 or 6 others. Our results indicate a confirmation of Boussingault. The evidence accumulates that Ville is an ass. I asked Bolard how he accounted for Ville's plants growing as they did. He answered "*Il a ajouté sans doute.*" He said nobody in Paris trusted them. Indeed I have not yet decided whether to treat Ville as though he didn't exist (silent contempt) or to expose him.

* * * *

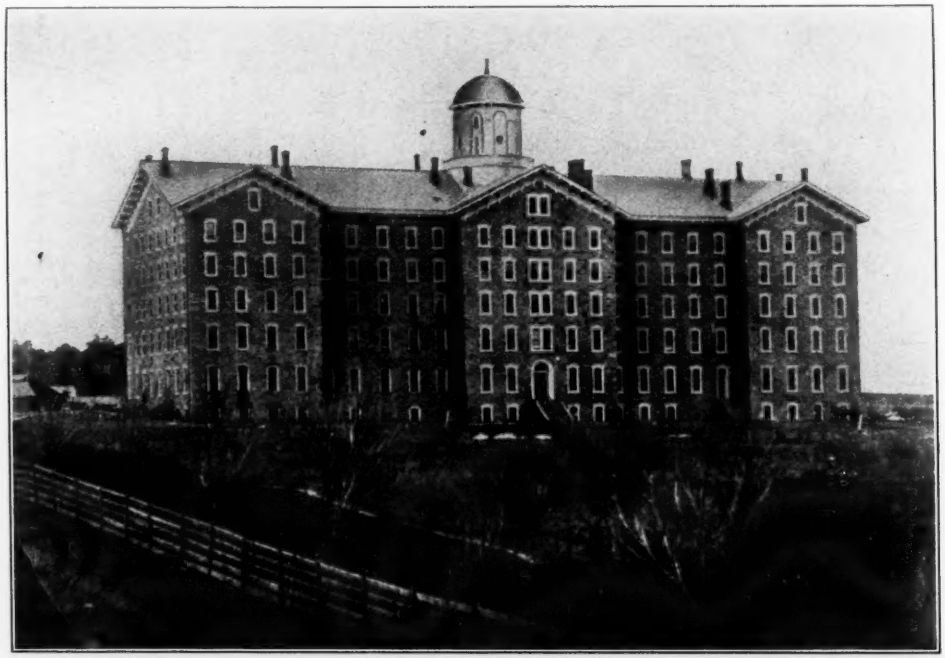
Harpenden West, St. Albans, England.
Nov. 8th, 1857.

MY DEAR JOHNSON:

I have only time now to drop you a line to inform you that I am going to remain another year in England, Mr. Lawes having offered me 1000 dollars to stay and repeat my experiments and also to make some....investigations this winter on the subject of the power of soils to absorb, retain, and give off NH_3, also upon the condition of the N in soils. I am now laying out a plan for investigation and have not one minute of time to spare for anything else as my study at night scarcely suffices to keep my hands at work in an intelligible and rational way during the day. You told me Liebig once proposed this subject for you to work at. Perhaps you could make some suggestions that would be of service to me—I would be thankful for them—I can as yet think of no plan that is competent to solve all the questions that the subject suggests. There are two difficulties suggested by agricultural facts.

1st. Clover won't grow on the same plot year after year though minerals, ashes of clover, rotted clover, or farm yard manure be applied *ad libitum* to the soil. It won't grow in two consecutive four-course rotations on the same land. Nothing short of an 8 years' rest from clover suffices to ensure a crop to the English farmer.

2nd. A certain quantity (W) of wheat containing a quantity of (N) of nitrogen can be cut from the Rothamstead fields without manure every year. But W is only half a crop. If the field lay fallow each alternate year the crop (W') will in each intermediate



Courtesy of E. W. Runkle

THE PENNSYLVANIA STATE COLLEGE IN 1863

This building, known as "Old Main," was completed in 1863, under the presidency of Dr. Pugh. The institution was then known as The Agricultural College of Pennsylvania. It assumed its present title in 1874.

year be doubled so that ($W' = 2\ W$) and the (N') nitrogen of (W') is ($N' = 2N$) also if nitrogen be added to the soil in the form of NO_3 or NH_3 then the quantity every year without fallow will be $= W'$. But what is remarkable if instead of fallow each intermediate year we plant beans and these beans remove a quantity of nitrogen from the soil greater than (N) that taken out by wheat without fallow—then the amount of wheat alternating with the beans will be $= W' =$ that obtained by fallow = that given by the addition of ammonia. Now by what continance in chemical philosophy or human logic or the "*Gesund Menschen Verstand*" is the "*Wissenschaft*" going to meet this "*Widerspruch.*" What do you think of it?

I was at the London chemical society and was made an associate for the year, so if you want a paper read I shall be most happy to do it for you.

Dr. Caldwell of Lunenberg, Mass., and I are translating that little work "*Précis d'analyse qualitative, &c.*" of Gerhardt and Chancel. It gives the organic chemistry of more than other books—what do you think of it? We are going to rearrange its matter so as to separate the organic from the inorganic which they don't. I sincerely hope Caldwell will get into a good position—none of my Göttingen American acquaintances merit it as much as he—none were as industrious—none more successful—and yet none as modest and unpretending as he. I'm afraid that his own modesty will be the means of his failing to be appreciated by those who have *positions* to give. If it lay on your way, Johnson, and you would lend him a hand you would reward merit and oblige your friend.

Evan Pugh.

P. S. I have translated Stockhardt's reply and shall send you a copy. Wollf has lately done the thing *up brown* in a long series of letters just out which I shall probably translate. Liebig has just finished a lot in the Augsburg *Zeitung*.

* * * *

Harpenden, March 14th, 1858.

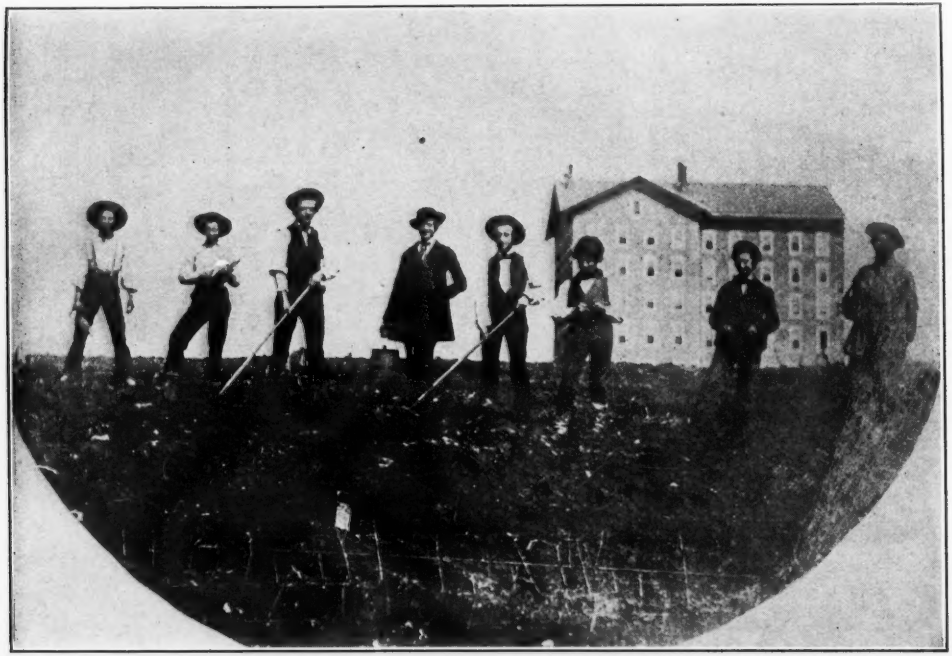
MY DEAR JOHNSON:

Thanks for your report on the agriculture &c of Connecticut. I shall send or get Dr. Gilbert to send you our last Rothamstead paper just out on the growth of barley with different kinds of manures. I have Stockhardt's last reply to Liebig translated but have not yet got it published. English ag. editors don't like controversial things, some of them are too great asses to be able to comprehend the true issue of the controversy and can only say that if one man says this and the other man says the other, the poor farmer puzzled with the mysteries of debate will be led to doubt both.

You have seen Liebig's new views of the relation of insoluble substances to plant—that insoluble substances are taken up by the plant (that water in the soil is not the agent that brings the nutriment into an assimilable state for the plant).

If you take the French ag. journals you will see that the French are stealing our results before we publish them so eager are they to add the influence of our experiments to their side of the question. Barold has published some things that we did not allow to come out till the close of this summer. We are expecting a visit from Boussingault this summer. He is quite cautious about coming though is very respectful in writing. Ville promises to bore us with his presence. I have told Mr. Lawes and Dr. Gilbert that such is my faith in his dishonesty that I would not trust my plants in his presence where salts of ammonia were in his reach!!!

I have had a jolly time attending all the meetings of the Chem. Soc. and some of the Royal Soc. this winter; we take tea after meeting, Chem. Royal and Linnean Soc. all together. To meet such men as Faraday, Lyell, Graham, Hoffman, &c, &c, is not "small potatoes" by any means.



Courtesy of E. W. Runkle

An Agricultural Laboratory Group in 1859

Members of Dr. Pugh's first class at the Farmer's High School. Old Main, then under construction, is shown in the background.

An occasional *soirée* has afforded opportunities for doing the social in the society of ladies and I have done much more of this kind of social in England than anywhere else in Europe. I bot. the *Phil. Transactions* ($250) the other day. I have bot. about $500.00 worth of English books so that my library looks again respectable. I send this by my good friend and old associate Dr. Caldwell.

* * * *

Arcard Hotel, Phila., Oct. 18th, 1859.

MY DEAR JOHNSON:

A complicated series of circumstances which I need not stop now to detail have so muddled my consciousness of past events that I really am not confident whether or not I have written to you since I came home, I am certain that I have commenced more than one letter that I have not sent.

Perhaps it may not be amiss in a few words to inform you that on the 3rd of last August at 12 o'clock I was with my ticket to N. York in my pocket, at Liverpool and ready to start at 2 P.M. for America but $1\frac{1}{2}$ hours before starting I received a telegraphic message informing me that the Penn. Ag. College had sent me 800 dollars to purchase apparatus with.

I then left Liverpool for London, thence to Hamburg—Berlin (saw Gustav Rose who sent some things to Dana, H. Rose, Schultz, Fleett, &c), Dresden (saw Stockhardt, who wished to be remembered to you and also those experiments with plants in water), Chemnitz (Dr. Wunder sends his *Grüsse*), Leipsic (*Grüsse von Erdmann*), Moeckern (saw Knope, he has recently written a good work "*Lehrbuch der chemischen Methoden*"), Jena (saw old Schultz who has been much interested in ag. schools and national economy), Göttingen (saw old Wöhler's familiar old grin), Weende (saw Dr. Henneberg's experiments), Giessen (&c, &c), Bonn (didn't see Hartstein but saw his Lab. &c), Heidelberg (didn't see Bunsen), Hohenheim (saw Woltz and the &c, &c.'s), Munich (met Liebig, Wöhler, and Kopp—had a jolly time), Weghan Stephan (farm school for ag.), Strasbourg, &c, &c, Paris ....., Cirencester (saw Völche). He thinks your summary in Silliman's *Journal* is good as also does Stockhardt (it certainly is, too). And finally left for New York by *City of Baltimore* on the 14th of Sept. and landed the following 27th after a stormy disagreeable seasick passage of 13 days. I called on Joy but did not meet him (how does it come that Joy has got such a good place and the rest of you have not?). And after a few days came on here and saw Judge Watts, the president of the board of trustees of Penn. Ag. College. I have since been home—spent a few days and am back again to go in a few days to the school—I took tea yesterday evening with Dr. Elwyn. He says you have just published something on the American phosphates, I wish to see it—can't you send it? I have thought of doing something of that kind if you have not done it all.

Do you know any good book on *ag. science* for a text book, a book more thorough, more advanced and with about 1000 fewer mistakes in it than I. L. Campbell's A. M.?

Can't we all put our heads together and get up a set of books on scientific ag. (or rather on science so far as it relates to ag.) which all of us who expect to teach ag. science, in contradistinction to ag. quackery, can adopt?.....

* * * *

The preceding extracts, which have been quoted from Dr. Pugh's letters, constitute only a part of the record of his chemical experiences and observations in European countries. It is hoped that all of his correspondence may be published with an account of his life which, although brief,

was filled with many notable accomplishments. The letters quoted, which were written when Pugh was between the ages of 25 and 31, show a remarkable keenness of observation, a delightful sense of humor, and a wonderful maturity of judgment for a man so young. The last letter quoted, with its outline of a plan for publishing a set of books upon the applications of science to agriculture, shows that Pugh had definite ideas as to what he hoped to accomplish. His early passing was a great loss, for he was a man who was far in advance of his time. Had his brilliant young life been spared we are confident that by the force of his leadership the great movement which began in the eighties for the promotion of agricultural chemistry and scientific agriculture, would have been advanced by at least a decade.

UNITED STATES CIVIL-SERVICE EXAMINATION

The United States Civil-Service Commission announces an open competitive examination for Junior Technologist. Applications must be on file with the Civil-Service Commission at Washington, D. C., not later than April 8th.

The examination is to fill vacancies in the Bureau of Standards, Department of Commerce; in the Geological Survey, Department of the Interior, and in positions requiring similar qualifications, for duty in Washington, D. C., or in the field.

The entrance salary is $2000 a year. Higher salaried positions are filled through promotion.

The optional subjects are (1) ceramics, (2) paper technology, (3) petroleum technology, (4) rubber technology, (5) textile technology.

Competitors will be rated on general chemistry, elementary physics, mathematics up to and including calculus, and practical questions on each optional subject chosen.

Full information may be obtained from the United States Civil-Service Commission, Washington, D. C., or the secretary of the United States Civil-Service Board of Examiners at the post office or customhouse in any city.

Faraday's Diaries. Of the diaries of Michael Faraday, which are expected to be published in about eighteen months' time, Sir William Bragg gave some interesting preliminary glimpses in a lecture recently at the University of Manchester. "I do not believe," Sir William stated confidently, "speaking of them collectively, that there is in the scientific world a diary quite like it in its fullness and completeness." Most of the work Faraday did has, of course, been described in his *Experimental Researches*, but the attraction of this, as of most other diaries, is that it reveals something of the man himself, the workings of his mind, his directive ideas, and his attitude toward the great problems of physical science he set out to investigate. The notes cover about six volumes of foolscap, each of several hundred pages, all written in Faraday's very neat, small hand. They are to Sir William Bragg so human and interesting because "all the time you see what he is trying to do." One innocent remark recorded when Faraday was nearing sixty years of age, and when he had spent a life-time in the most fruitful observation and experiment, might well be the first rule of every laboratory—"I must learn to observe."—*Chem. Age*

CHEMICAL ACTIONS OF LIGHT[1]

MAX BODENSTEIN,[2] FRIEDRICH WILHELM UNIVERSITY, BERLIN, GERMANY

In considering chemical actions of light, you will first think of the processes of photography. You know that when an emulsion of silver bromide and gelatin spread over a film is exposed to light in the camera, a latent image is formed. What this latent image may be I shall discuss later. Here I want to mention its effect only: the exposed area which comprises the latent image has become developable, which means that the substance on the plate has been changed in the sense that where the light has acted, the silver bromide can easily be reduced to metallic silver. This process of photography is of a certain interest, industrially, but of much more importance, because it is basic to our existence, is another photochemical process—that of the growth of plants. Only under the action of sunlight do plants assimilate carbonic acid and split off the oxygen which we need for our respiration. At the same time they combine the carbon with the elements of water, building leaves, fruits, wood. Here is the source of our food, our clothes, our building materials, our heat, our energy. In spite of the growing use of water power, the carbon produced by later changes of the substance of the plants is still the most important source of our energy.

The photographic process and the growth of plants are examples of two different kinds of photochemical processes. We call the growing of plants a process of storing energy. If we compare the initial substances with those formed by this process, we easily understand what that means. The first substances are carbon dioxide and water. The substances formed are very complicated, but we may say simply that they are carbohydrates, of the general formula $(CH_2O)_n$ (sugars, starch, cellulose, etc.). Besides the carbohydrates, there is also formed, of course, oxygen. Thus we can write an equation:

$$nCO_2 + nH_2O = (CH_2O)_n + nO_2$$

If we read this equation from right to left, then we have the process of combustion of starch or cellulose. We know that combustion gives us a remarkable amount of energy. Thus we may say that carbohydrate plus oxygen contains more energy than carbon dioxide plus water—when the reaction proceeds from left to right, a system poor in energy is changed to a system rich in energy. We have stored energy, converting of course the energy of the sunbeams, which was needed for carrying on the process.

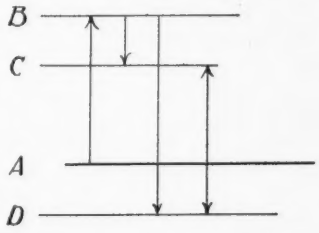
What are the energy relations in the case of the photographic plate? If we keep a plate in perfect darkness for a long time, then it becomes foggy

[1] Public lecture delivered at The Johns Hopkins University, Monday, December 9, 1929.

[2] Dr. Bodenstein was at Hopkins for several months last fall as the James Speyer visiting professor of chemistry.

in development. A latent image has been formed in the dark, in every way identical with that which would be caused by a short general illumination. We find, therefore, that in photography light merely accelerates a process which occurs spontaneously, though very slowly, in the dark. This means that the product of the reaction is poorer in energy than the initial substance. The acceleration of a slow, spontaneous process is called in chemistry catalysis, and so one may call this kind of photochemical process catalytic.

The difference between these catalytic processes and those which store energy seems to be very important, but really it is not so great. In the catalytic processes, as in the others, the energy of light is consumed. Only such light is active as is absorbed by the reacting substances. This fact was discovered as early as 1818 by Grothus and shortly afterward by Draper. In both cases the radiant energy is absorbed and transformed into chemical energy by the formation of some unstable intermediate substance. This substance then reacts spontaneously in the second step of the process which in every case releases energy.



In the accompanying illustration, A may be the energy level of the initial substances. By absorbing energy they are elevated to the level B. From that they drop by spontaneous reaction either to C or D. In the first case, from A to C, there has been a rise of energy: we have had a process of storing energy. In the second case, from A to D, there has been a drop of energy: we have a catalytic photochemical process.

In the decomposition of ammonia, we have an excellent example of the two processes. Ammonia is a substance which easily decomposes into nitrogen and hydrogen, and the synthesis of ammonia was therefore very difficult. The tendency of the two elements to combine, and that of ammonia to decompose, establishes an equilibrium, which is reached at room temperature and atmospheric pressure if 98% ammonia and 2% of the free elements are present. Now if we expose pure ammonia to light, it is decomposed. The gas mixture approaches its equilibrium, which it tends to reach even without the action of light: we have a catalytical photochemical process. If, on the other hand, we expose to light a mixture of 50% ammonia and 50% free elements, the ammonia is decomposed in the same way, but now the system removes itself from the state of equilibrium: we have a process of storing energy. Between the two cases, however, there is not the slightest difference. A given amount of absorbed energy produces the same amount of decomposed ammonia. The ammonia is elevated to a certain energy level and for this elevation

the same amount of energy is required, independent of whether in the whole process a gain or a loss of energy occurs.

Is it possible to make some general statements on the amount of the consumed energy? Our knowledge of the subject is as yet rather new and only since we acquired it has it been possible to systematize photochemical reactions. In order to explain, I must go back somewhat farther.

You know that matter is not a continuum, but is composed of small particles, atoms, or molecules, which are in turn combinations of atoms. That has been for a long time a hypothesis or theory which again and again has proved useful, until today we know with all desirable certainty that all substances are really composed of these small particles. Furthermore, we know today that energy, at least as far as we are interested in it here, has, roughly speaking, an atomic structure also. Between molecules, small quantities of energy may be transferred but such quantities of energy cannot be subdivided at will, any more than matter can be subdivided infinitely. This is the basis of the quantum theory first deduced by Planck, and later applied to photochemical processes by Stark and more precisely by Einstein. The sense of this application is that in every case one quantum of energy affects one molecule of matter. This "Einstein law" is the basic answer to our question as to the amount of consumed energy.

However, if we consider the facts, the case seems to be not so simple. First, it is obvious that there are a great number of substances which really are not affected by any number of quanta—carbon, metals, granite, and a great many other substances are exposed to brightest light without change. Then there are substances which are sensitive to some rays and not to others. This may be caused by the fact that these latter rays are not absorbed but transmitted (this is the reason why red and yellow do not act on the photographic plate) but it is sometimes true when these substances do absorb the rays in question. The reason is that the energy content of the quantum is not at all a given unchangeable magnitude but that it changes with the wave-length, which is to say with the color of the light. The numerical value of a quantum for a given wave-length is the product of a constant, the so-called Planck's constant, with the number of vibrations per second. The following table shows for the visible and ultra-violet light the figures of the magnitude of the quantum:

BEGINNING	RED	YELLOW	BLUE	VIOLET	ULTRA-VIOLET	
					Near	*Far*
λ	7500	5900	4900	4550	3950	2000 Å
ν	400.0	508.5	612.2	659.3	759.5	1500×10^{12}/sec.
$h\nu$	2.62	3.33	4.01	4.32	4.97	9.9×10^{-12} erg
$9.06 \times 10^{23}\ h\nu$	37.8	48.6	57.9	62.3	71.8	142 kg. cal.

In the last horizontal line the quanta have been multiplied by Avogadro's number to give the quantum energy connected with one mol of matter. For convenience these values are expressed in kilogram calories rather than ergs. It has been suggested that this quantity be called the "Einstein," since it is entirely analogous to the Faraday. One sees that a quantum of violet light is nearly double the size of a quantum of red light and that the ultra-violet quanta are much greater still. Therefore, one quantum of ultra-violet light is able to give a much stronger action. If the molecules of a good dyestuff are resistant to a quantum of visible light, they may be attacked and bleached by those of ultra-violet light. In this way, it is easy to understand that in many cases there may be no reaction in spite of absorption of energy. The quanta are too small to cause reaction.

Now if one quantum of a suitable size is absorbed, one molecule of substance must react. On this is based the postulate of Einstein, a very simple relation. If we examine it in the light of experiment, we find many cases in which it is well supported. I want to discuss only one, because in this particular case a greater number of consequences of Einstein's postulate has been experimentally investigated. This is the photochemical decomposition of hydrogen iodide. The following table gives the result of experiments performed by Emil Warburg.

DECOMPOSITION OF HI

λ	2070	2530	2820 Å
Molecules decomposed	0.292	0.356	0.404 million
Absorbed quanta	0.144	0.185	0.208 million
Ratio	2.03	1.96	1.94

The last line shows that with all wave-lengths, as exactly as it is possible to estimate in view of the inevitable experimental errors, 2 molecules of HI are decomposed by one quantum of light absorbed. That this figure is 2 instead of 1 arises from the fact that the first product of the decomposition does not remain unchanged. We may write the equation of the first step:

$$HI + h\nu = H + I$$

The H atom reacts according to the equation,

$$H + HI = H_2 + I$$

and both I atoms must combine with each other to form the I_2 molecule, because they are too inactive to react in the same way as the H atoms. Thus the sum of these equations is

$$2HI + h\nu = H_2 + I_2$$

the result of the experiment.

Whether the temperature, which, as you know, ordinarily has a great influence on chemical reaction, changes this fact, has been investigated by one of my pupils. It does not. Further, there is no change if we use liquid hydrogen iodide instead of gaseous, or if we add foreign gases. In every case we have the relation postulated by Einstein, that one quantum decomposes one molecule. There are some other well-investigated reactions of this kind, among which is the latent image, as I shall explain later.

On the other hand, there are exceptions, at least as many of them as there are proofs, of the Einstein law. That looks very bad. But discussing these exceptions, just after Einstein had pronounced his postulate, I could show that they may be explained very plausibly. First, there are cases in which the yield (that is, the number of decomposed molecules divided by the number of absorbed quanta) is less than unity. That is easy to understand. I have already said that the absorbed energy elevates the substance to a higher energy level from which it drops later, forming the final product. If the energy is small, as for instance in the case of the quantum of visible light, which does not affect the good dyestuff, the absorption nevertheless is connected with the elevation of energy, but this elevation is not sufficient for reaching that high level which is needed for chemical reaction. The substance remains unchanged, only it is heated, since in some way, of course, the absorbed energy must act. From this standpoint it seems that there ought to be a sharp threshold: a certain wave-length in the absorption of light ought to give only heat because the quanta are too small; shorter wave-lengths (for instance, blue, violet, ultra-violet) ought to furnish quanta large enough to cause reaction. In fact, this threshold exists but it is *not* sharp. The reason is that the individual molecules in the initial state have not all the same energy content before absorption of light. In a gaseous system of a temperature of say 20°C., the mean energy content of all the molecules corresponds to this temperature, but of the 3×10^{19} molecules in 1 cc. of this gas, there are some whose energy is equivalent to a temperature of 10,000°, some 5000°, the greater number nearly 20° and some of very low temperatures. If we take this fact into consideration it is obvious that the action of light cannot suddenly be cut off at any point of the spectrum at any given size of the quanta, but the change from activity to inactivity must be gradual. In the region of this change, the yield of course is smaller than one molecule per quantum. Ammonia, whose decomposition we have already discussed, shows here also that this assumption is right. At room temperature, decomposition of one molecule needs 4 quanta of ultra-violet of very short wave-length. If we raise the temperature, the mean energy level from which we must elevate the molecules is raised and the yield becomes bigger, so that in the region of 300°C., it reaches the value of one molecule per quantum.

Therefore, there is no difficulty in understanding why the yield under some circumstances is much less than that prescribed by the law of equivalency. But there are cases in which there is a yield greater then unity and sometimes very much greater, such as a yield of 1,000,000 molecules per one quantum. It seems impossible to speak here of the law of equivalents, but even this deviation is easy to understand and the assumption which accounts for it has become useful in its consequences not only for photochemical reactions, but in the field of dark reactions as well. It is the assumption of the "chain reaction." I shall explain it by an example, the same one which has given this enormous yield; that is the formation of hydrogen chloride from a mixture of chlorine and hydrogen. This action was first studied (1850–55) by Bunsen and Roscoe and since that time there have been a great number of researches made upon it but nevertheless we do not know exactly what is the mechanism of this very difficult reaction. Thus I cannot say with certainty that the chain I will give here (first suggested by Nernst) is exactly what really happens, but in general it does and in any case it shows what a chain reaction is. I may give it here very simply by the following equations:

$$Cl_2 + h\nu = 2Cl$$
$$Cl + H_2 = HCl + H$$
$$H + Cl_2 = HCl + Cl$$

The Cl reacts again with H_2 and thus is formed a chain which may become very long until finally it will be broken by some event which from our point of view is not interesting. This chain reaction was of course an assumption whose probability has been established not only by the fact that the yield was very great but also because this and all similar reactions show in many respects the behavior of normal dark reactions, which really they are. But, in the meantime, it has been shown by Weigert and Kellermann, that really in the case of the chlorine and hydrogen mixture, the first action of light is followed by a long, dark process. They have exposed the gas mixture to the light of a spark for $^1/_{1,000,000}$ second and afterward, by the streaks formed by the heat of the reacting substances, they have observed that this reaction took place in not less than $^1/_{200}$ to $^1/_{20}$ second. That of course means that this chain reaction is really a dark reaction. It is merely initiated by the action of light as far as the Cl atom which starts it is liberated by the light absorption. If that is right, the chain must be the same, if in the mixture of Cl_2 and H_2 by any other way Cl atoms are produced, or since the H atom in the chain is equivalent to the Cl atom if we add to it H atoms. Cl atoms have been produced in that mixture in three different ways, the H atoms by one way. In every case this chain reaction has been the result.

It has not been possible in every case to show by direct experiment that

the first act is followed by a chain reaction, but since these chain reactions show characteristics of normal dark chemical reactions, we are allowed to assume them if we observe the latter and, on the other hand, if the yields exceed the law of equivalence, this excess may be explained in the same way as it has been done here. So we may say in general the first step of the action of light on matter is covered by Einstein's law of equivalents—one quantum affects one molecule. This light-affected molecule reacts later in one of a number of very different ways.

That I think is the basis of our modern knowledge of photochemistry.

Now I want to speak about three most important chemical processes somewhat in detail—the formation of the photographic image, the growth of plants, and the act of seeing, for this is a photochemical process too, at least in its first steps. Concerning the photographic plate, we know that it is possible to get a latent image in the camera which can be developed on a plate, but what is this latent image? This question has been answered only lately. Assumptions had been made earlier, but a definite answer has been given only of late. The reason is that the quantity of the changed substance in the plate is exceedingly small. In the normally illuminated plate it is impossible to detect the change even with the most sensitive microscope or the finest analytical methods, except, of course, the ability to be developed. It is probable that the photochemical process is a decomposition of silver bromide. This decomposition can be brought out by exposing silver bromide to an intensive light and passing over it a current of air. Then this current takes with it the bromine, which is easily estimated afterward. Under ordinary circumstances no current of air is present, but, although silver and bromine react with each other very quickly, the latent image is stable for a long time. Free bromine cannot exist in the illuminated plate. It must be accepted by other substances present and it may easily be that the gelatin with which the silver bromide is mixed plays this rôle. One may imagine therefore that the substance of the latent image really is silver—silver which has formed silver crystals, which, as we know, are able to accelerate the formation of more silver by the reduction of silver bromide by the developer. That metallic silver is really formed and that it is formed in the proportion of one atom of silver for one quantum absorbed has been shown by Eggert and Noddack. The experiments giving this result do not show as good an agreement as those given above on the decomposition of hydrogen iodide. The measurements were much more difficult. The estimation of this small amount of absorbed energy is extremely difficult because it is absorbed not only by the silver bromide, which is of interest for this study, but also by the gelatin. But finally all these difficulties were overcome, and one may now say that Einstein's law really holds good for the photographic plate.

There remain, however, a great number of questions concerning the

formation of the photographic image which are not yet elucidated in all details.

The photographic plate is a human invention and of all photochemical processes which are, in this sense, artificial, it is the most important. But there are two "natural" photochemical processes which are much more important, the growth of plants, which I have already mentioned, and the act of seeing. This also is a chemical action of light, or rather its first step is such an action, occurring in the eye and followed by physiological and psychological processes which lead the accepted stimulus to the brain and change it into the sensation.

The investigation of these processes is, of course, extremely difficult and I can speak here only of the first act, the changes which take place within the eye. We know that the retina is composed of a large number of sensitive organs. These are of two different kinds working one beneath the other, the cones and the rods. The rods are covered with a colored substance, the seeing purple; the cones are not appreciably colored. We know further that the color of the rods is changed by illumination from purple to yellow, and that under weak light the seeing is done by the rods, so that in the twilight we are not able to distinguish colors but only see that grey is grey.

The fact that the seeing purple changes its color is indubitable proof of a photochemical reaction. All our further knowledge about this process can be gained only by indirect methods because it is impossible to touch the sensitive organ of the eye with our rough chemical agents. First, one may examine how the reaction of the body to stimuli changes if we change the conditions of the experiment: one uses the second act of seeing, the psychological one, as a reagent for the first. Here it is a well-known fact that the eye is able to adapt itself to different degrees of illumination. That is done first to a moderate degree by changing the aperture of the pupil, second to a much greater extent by changes within the retina, a process which is not very rapid. Here we may assume that by the action of light a sensitive substance, say A, is changed into another, B. The retina adapted to weak light would contain much A, which would be able to absorb enough of even a very faint illumination to receive a stimulus. Adapted to bright light, there would be less A but sufficient still to have the same absorption and to produce the same stimulus from the bright light.

Now one may change suddenly the intensity of the general outer illumination and then illuminate the eye by a special light which is the same in every experiment or changed from one experiment to the other in a measurable manner. If one does this at different times after the sudden changes of the general brightness, then one is able to measure how quickly and following what law the gradual process of accommodation takes place.

Then one may compare the law observed here with the well-known laws of slow chemical reactions. One is able to draw conclusions as to the kind of process of adaptation and, further, about the kind of disturbance caused by the special illumination, that is, by the act of seeing itself. In this way it is possible to get some general knowledge, although all details of the actual chemical reactions remain unknown.

Such experiments have been excellently performed by Selig Hecht, Columbia University, New York, with lower animals, for instance, clams. The conclusion is that not simply the substance A is transformed to the substance B by the action of light, but instead of the one substance B we must put two substances, B and C. But otherwise all relations are as already stated: the concentration of the sensitive substance is great if the seeing organ is adapted to weak light, is small if adapted to bright light, and in all cases the same amount of a chemical change of this substance gives the same stimulus.

It seems to be very difficult to make similar experiments with the human eye. But here there are some extended measurements concerning the relation between visual acuity and brightness of illumination. These measurements have been discussed and calculated recently by Hecht also. He has deduced their laws and given their theory. It would be very interesting to give a report on the striking quantitative relations he has found. But that would require too much space; thus I may only state that all these observations agree perfectly with the photochemical reaction here assumed.

Those researches give some idea of why we are able to distinguish bright and dark, but not the slightest idea of why we see color. To understand this phenomenon, one must make the assumption that the cones are divided into different kinds, one being sensitive against blue, one against red, and one against green. One can show that these three colors are sufficient to give the sensation of all existing colors, white included, by the addition of suitable amounts of them in the proper proportions and in the last-mentioned paper of Hecht he gives some facts which favor this theory. But it may be possible to explain the fact of seeing colors also by supposing only one kind of cone. That explanation has been offered in an assumption developed by Weigert, though as yet only by a kind of model. He had observed that layers of silver chloride and silver bromide under certain circumstances undergo a specific change in colored light. They become green in green light, blue in blue light, a fact which may be understood by the assumption that the particles formed in these emulsions are arranged side by side in a definite manner, in agreement with the different colors. The same phenomenon has been observed also with dyestuffs absorbed in a thin film of collodion, especially if the layer is colored only very slightly.

These observations are then transferred to the eye. The cones seem to be colorless, but the assumption is allowed that they too, as well as the rods, are covered by some layer with a very weak color. This layer would be able to undergo the changes observed on silver salts and colored collodion films and, if turned to green, send the stimulus "green" to the brain. We then only need the assumption that this layer returns to its normal state after the illumination is over—which is not done by the model, but which we surely are allowed to assume for the eye.

In connection with this theory there may be understood another well-known phenomenon, too. If we shut the eyes after a strong colored impression, for instance, of the setting sun, then we think we see an after-image. This does not appear in the right color, but it has the complementary color. That may be esteemed as indication of a kind of adaptation against a too strongly colored light, a production of a greenish dyestuff neutralizing the red of the sun, which needs some time to return to the normal state just as the substances A and $B + C$ in Hecht's experiments on general adaptation.

Neither the difficult experiments and calculations of Hecht, nor this ingenious analogy of Weigert solve the problem of seeing nor is that done by earlier experiments and theories of a more physiological kind. They prove that the action of the eyes is based on photochemical processes and they give some idea about them. Further painstaking investigations are needed before we shall fully understand this wonderful process.

Not much better is the state of our knowledge about the other important natural photochemical process, the growth of plants. As I have already mentioned, the reaction taking place here is the change from carbon dioxide and water to oxygen and a carbohydrate. For discussing this process, let us return first to the act of photography.

The silver bromide of the photographic plate absorbs blue, violet, and ultra-violet light and thus is easily affected by these colors. It does not absorb green, yellow, or red light, and the consequence is that if one uses it for making a picture of a beautiful red evening sky, green woods, and white houses, only the white houses are truly reproduced, while the red sky and the green woods become clear in the negative and perfectly dark in the positive. But there are so-called orthochromatic plates which are more or less free from this fault. They are prepared by impregnating a normal plate with a solution of some dyestuff. This impregnation may be very well done, but the crystals of silver bromide have of course not changed their color. Just as in the ordinary plate, they absorb only blue and violet, and if they react now under the influence of the longer waves, it is possible only in this way—that the molecules of the dyestuff absorb the energy of this light and transfer it to the silver bromide, which then acts in the same manner as if the energy had been absorbed directly by

the silver bromide itself. The molecules of the dyestuff are not changed chemically by this process. They are able, as has been proved by experiment, to transfer the energy to 20 or more molecules of silver bromide and make them react. We do not yet know in detail how this transfer of energy happens, but we know that it occurs also in gaseous systems, where the relations are much simpler. It is to be hoped that this question will soon be clearly solved, but for our discussion it is sufficient to state the fact that this energy transfer is possible and that these "sensitized photochemical reactions" are very widely occurring phenomena.

Sensitization is for photography a useful enlargement of its application. For the growth of plants it is basic. The initial substances of this reaction are carbon dioxide and water. Both are colorless, both are permeable to the rays of visible light, but they react under the influence of visible light and thus they need sensitization. That is accomplished by the chlorophyll, the green dyestuff of the leaves, accompanied by some less important similar substances. The chlorophyll absorbs the beams of visible light, especially the red and yellow ones, and transfers their energy to the carbon dioxide or possibly to its hydrate, carbonic acid. It is easy to extract the coloring substances of the leaves and to illuminate a liquid solution of this with carbon dioxide. There is not the slightest success, however. The process of assimilation is only possible in the living plant and from the fact that it is checked by certain substances we may conclude that it takes place at the surfaces of the chromosomes to which the leaves owe their green color. That of course makes research extremely difficult. Thus we are still unable to say what is the mechanism of assimilation. We know the initial substances, CO_2 and water. We know the final products, starch, cellulose, lignins, albumins, etc. It is, of course, impossible that these complicated substances are formed in one single act. It is evident that in the first step much more simple substances must be formed and that they then in spontaneous dark reactions give rise to the final products. For this first step, Willstätter has suggested a theory—that the hydrate of carbon dioxide, carbonic acid, under the influence of light, is rearranged to a peroxide of formaldehyde. This then splits off the oxygen and the resulting formaldehyde, which is the most simple carbohydrate, is then condensed to the other final products. Certainly, this theory does not contain impossible assumptions, but it is not at all proved by experiment.

The results concerning energy are somewhat more precise. Here there are excellent measurements made by Otto Warburg and Negelin. They have shown that almost exactly 4 quanta are needed to release one molecule of oxygen, independently of the color of light, red, yellow, green, or blue, as far as these are absorbed. This experimental result is very clear, but it is impossible to say what it means in the light of Einstein's law. There

is one fact, however, which is of extreme interest. We may compare this energy with that which we are able to obtain by burning the final product, for instance, starch with oxygen—that means reversing the process of assimilation. The energy we get by that means in the form of heat is 70% of that which has been absorbed from the red light. With a yield of 70%, Nature uses the energy of the sunlight for arranging a process which is so complicated that we cannot yet understand it and still less find out how to reconstruct it. This fact forces us to be modest in spite of all the theoretical and technical successes of modern physics and chemistry.

This is one of the fundamental ideas to which the study of assimilation leads us, but there is still another. The sources of all our energy are the coal mines and oil wells, which are after all nothing more than residues of plants which have been grown millions of ages ago. In consuming them we consume a capital which has been stored from the energy of the sunlight in those past ages and even what is being accumulated in modern times is being used more quickly than it is being stored. For instance, consider the production of the enormous quantities of paper used for newspapers every day. The question arises—what shall we do if this capital should be consumed? The answer is very simple. We must have a process to substitute for the growing of plants, a process in which the energy of the sunlight is used for arranging a reaction which stores the energy in the form of highly reactive substances. We know a number of such reactions. For instance, it is very easy to decompose steam or carbon dioxide, and it would be much easier still to cause the products of this decomposition to react for getting energy. But the light which is needed for this decomposition is ultra-violet light, and thus we ought to put our energy producers into action where this ultra-violet light is available from the sun. That is several miles above the earth's surface, and that, of course, is impossible. Thus what we really need is a reaction which is caused by visible light. At present we know of only one, which has been found by Luther and Weigert. Anthracene, a product of coal tar, is polymerized under the influence of blue and violet light to the di-anthracene. This product in the dark reacts in the reverse, forming again the monomolecular anthracene, and the energy of this spontaneous reaction could be used. This research shows that it is possible to find such a reaction, but the substances used here are certainly not able to meet the conditions for the production of energy on a large scale. This will be the aim of the future industrial photochemist—to find a better substitute for the process by which in ages past plants have been storing the energy which we use today.

SYMPOSIUM ON "SELECTING THE CHEMIST-ELECT"

That portion of the program of the Division of Chemical Education at the Minneapolis meeting of the American Chemical Society which attracted record attendance was the symposium on "Selecting the Chemist-Elect" held on the afternoon of September 11, 1929. A discussion of the fundamental training and qualifications of a chemist which industrial organizations consider most important was led by representatives of some of our large industrial concerns, men who, from long experience in employing and directing chemists, were well qualified to participate. These were: IRVING LANGMUIR, *Associate Director of the Research Department, General Electric Company;* G. S. RUTHERFORD, *Assistant Superintendent of Manufacturing Development, Hawthorne Works, Western Electric Company;* W. JUDSON MARSH, *Hooker Electrochemical Company;* WM. J. HALE, *Dow Chemical Company; and* F. W. BLAIR, *Procter and Gamble Company. The meeting was conducted under the able chairmanship of* WM. MCPHERSON. *Several of the papers are published herewith.*

ADDRESS OF IRVING LANGMUIR*

In these days we have all learned to know the value of mass production. A large part of our progress is due to it, and the universities are to a great extent following the lead of manufacturers in recognizing the value of mass production of students and men with degrees. This has its advantages, for we need all grades of students. We need men who are willing to do analytical and routine work, and such men are going to be needed in large numbers, but the country would suffer tremendously if on this account all students were trained in the same way. We need also the superior students. The matter of their training is a problem interesting in itself, and it is of the utmost importance that it be well thought out in detail and that it be solved.

In my opinion an important move in chemical education is to go back to the high schools and arouse an interest in chemistry among large numbers of boys and girls, particularly among the best of them, for these are the young people who are to supply the superior students for whom we are looking. It will give us a large number of students already interested in chemistry from whom we can choose.

The whole trend of science in recent years has been the accumulation of enormous amounts of material, as we see from our publications, and the generalization and compilation of data on old phenomena. From the educational point of view this is bound to have a tremendous effect. It is no longer possible to teach chemists all that is known of chemistry.

* This is essentially the same address delivered by Dr. Langmuir on the occasion of the dedication of the Francis P. Garvan Chair of Chemical Education at The Johns Hopkins University, October 11, 1929, and which is referred to on page 281 of the February, 1930, issue of THIS JOURNAL.

It may have been possible fifty or one hundred years ago to have a man know through his college course a reasonable proportion of the sum total. This is impossible now. You will have to select subjects out of an enormous amount of material, and certain subjects may be chosen as examples of the whole of chemistry, so that a man will know how to apply to a particular situation principles he has learned in an entirely different field. When one went into chemistry fifty years ago, each branch had a fence around it. Take, for instance, the teaching of qualitative analysis. There was never a doubt about what should be taught in it. It seems to me that sort of thing should be abandoned, especially when we have to deal with superior students.

I have asked a number of men in laboratories, who have been trained as chemists, what criticisms they have to offer in regard to their own college courses, and the consensus of their opinions practically coincides with the estimate I have formed of my own course. What is needed is more fundamental training, more mathematics, more physics, and more fundamental chemistry, less of specific chemical application, less of applied chemistry. The methods are the important thing; the method of thinking, the method of using fundamental knowledge—these are essential. In teaching the application of chemistry and in teaching the method of applying fundamental knowledge, there is no harm in having a few practical subjects to work with, but the emphasis should be laid on the training as to the method of thinking, the method of applying the knowledge rather than on the knowledge itself; in other words, do not teach mere facts, except here and there; do not make that the main part of the course, but get down to the fundamental methods, stimulate interest and arouse enthusiasm for knowledge, for methods of acquiring knowledge rather than for an accumulation of knowledge. A college has to teach certain subjects; that is a business proposition; there cannot be one teacher or one instructor for all subjects. The work must be divided, but it seems to me that that should be regarded as a necessary evil and that it should have as little effect on the structure of the course as possible.

I remember in my own college work we had a course in assaying; we had, I think, three afternoons a week for one year in that course and it was obvious that everything that had to do with assaying had to be included in that course. It was not a question of whether the method used in assaying was as good as one that could be taught in quantitative analysis, but the point was that everything that properly came within the textbooks on the subject of assaying was a part of the course, so that the students should have a well-rounded-out knowledge of assaying. It was the same with the fencing off of analytical chemistry. That is a wonderfully good subject to teach. A man learns a great many useful facts; he gets the feeling of chemical substances. But in learning qualitative

analysis he should not be permitted to use sloppy methods that he will not be able to use in quantitative analysis. Courses in qualitative analysis should be taught in the beginning, but quantitative methods should be taught *from* the beginning. Why separate the two branches in a way that nobody has ever done except in a chemistry course? Why put nitrogen in and leave out tungsten and numbers of other things that are much more important than tungsten? Think of what importance the course has to a man; don't give it just because the faculty has assigned an hour for a course in qualitative analysis and nothing else. Work up a system by which you give a man the methods of thinking, the method of developing his own experimental ability, put the whole thing into a flexible system, and allow the students all the opportunities there are. Let the best man have the chance and arouse an interest in him to go far ahead of every one.

It must be recognized that it is impossible to give courses on all the subjects there are. Students are now usually allowed to select very largely the subjects they study. That is highly desirable, but they certainly should be guided very carefully, for they don't know what is important and are likely to choose the thing that seems interesting and easy. It is better not to try to give a course complete in itself. Its relation to other subjects must be kept in mind. It seems to me particularly valuable to have some very general courses. I know that the lecture system is much questioned by a great many people who do not believe in getting information in this way. Although lectures partly fail of their responsibility, I rather feel personally that what is learned through certain sorts of lectures is more valuable than information obtained in any other way. I have in mind particularly a course of lectures I attended at the University of Göttingen. A large number of students took the course. It was given by Felix Klein and the subject was mathematics, not any particular branch of mathematics, but all kinds of mathematics. It started with arithmetic, the simple theory of numbers. It went on to Euclidean geometry, algebra, calculus, etc.; what the differential or infinitesimal or integral calculus means, and how each is used. The professor told us about the eight-year old mathematical genius, John Guest; about the internal construction of the adding machine and the multiplying machine, a little about this, a little about that, so that when we got through with that course, we knew something about all branches of mathematics. It was a course in the philosophy of mathematics. It was very difficult and required a great deal of outside work. It stimulated reading. In order to learn the content of this course for himself, a man would have had to read the whole course of every branch of mathematics. After taking that course, I had a keen interest, which has lasted all my life, in the whole subject of mathematics.

Although there are few men who can give courses comparable to Klein's,

it seems that a good teacher of chemistry should be able to put before the students an idea of what a particular branch of chemistry is; for example, he should so outline a course in organic chemistry as to arouse a possible latent interest in organic chemistry, but not necessarily to make the student an organic chemist. If that interest is aroused, a student will be stimulated to study for himself the necessary details. Of course, the sort of lecture that simply gives facts that can be learned from books is worse than useless. A student learns things that will be of no use to him and gets lazy habits of acquiring information. What he needs is to find out how to find out things for himself, how to look up the literature for information to apply to his problems. The superior student cannot hope to collect facts and data on a large scale, over an entire field, but the plans and methods of science he has got to get in college and not outside. As in the course in mathematics of which I have spoken, so in chemistry the relationship of the different parts of the science should be kept in mind. Why go into one field of chemistry in all its little ramifications, examining all the little parts that should go into an encyclopedia on that subject, and all the time neglecting whole vast fields of science?

As regards the necessity of mathematics in the training of the chemist, we have had in this meeting of the American Chemical Society in the announcement of the production of para-hydrogen an object-lesson. The chemist, for the last few years, has needed mathematics. The handwriting is on the wall. I think the whole future of theoretical chemistry depends on the application of physics and the quantitative theory of mathematics, more so than any man has ever yet dreamed. Fundamental chemistry will have to depend on the ability of the average man to read and think along the lines of fundamental work. The chemists of ten or fifteen years hence are going to need much more mathematics than we have. Now, students don't like mathematics and many of them cannot absorb mathematics, but they should not be allowed to go through college thinking that mathematics and fundamental physics are not needed by chemists. They ought to have every opportunity to realize the importance of such new fields. There are new methods in mathematics that were discovered only a few year sago. Hydrogen might have been separated by any chemist, with no expense, at any time within the last ten or fifteen years. All he would have needed was some liquid air which he could have purchased in any large city for a few dollars, and if he had had the knowledge, he could have produced para-hydrogen fifty per cent pure. But without the knowledge he never in the wide world could have done so. I suppose it would have been fifty years before para-hydrogen would have been discovered by the use of ordinary methods. Now this is going to rehabilitate the methods of thinking, so that every chemist will begin to reason in terms of technical construction. Even now, methods

are different; a student learns many of the new methods in high school, which, a few years ago, would only have been taught under theoretical chemistry. Now things go faster, and we must recognize that this new mathematical development is going to be of an importance in five or six years that it is difficult to realize at present.

I have been trying to emphasize throughout this talk the necessity for training in the ability to get information. In our laboratory we use very few chemists; our work is nearly all physics, and yet we take a good many men who have had chemical training. Dr. Whitney, the director of the laboratory, is a chemist; Dr. Coolidge, assistant associate director, and myself, are both chemists; and yet not one of us has taken chemistry as a part of our regular work. Perhaps what I have to say on this score is not strictly applicable to the purely chemical industries but I have a very strong feeling that industry doesn't want a man trained in the knowledge of the things to which he is to be assigned. We start him on experimental work, and we want him to use his intelligence; we want him to be able to read things correctly, to be able to get his own data, to work out his own methods; he must be able to go down to the library and pick out things for himself. He certainly must know physics and chemistry, and the application of them, at the time he leaves college. The particular methods that are going to be used he will learn from other members of the profession; we will see to that. We have our own methods of doing things. He will learn our point of view from his associates, and what he learns from them will be far more pertinent to his work than anything he learns at the university. But we cannot stop to teach him fundamental chemistry and mathematics and physics.

A chemist who does not know mathematics is seriously handicapped. Mathematics is nothing but a tool from the point of view of a chemist or physicist. It does not create new knowledge in itself; you must put into it essentially what you get out of it. Now an experiment in physics or chemistry is fundamentally complicated. In practically every one, simplifying assumptions are necessary. There are many men who have had courses in mathematics, who, when faced with a practical possibility in physics or chemistry, are unable to make simplifying generalizations because their background in mathematics is so deficient that they are unable to transpose their knowledge of it to other fields. Much practice is necessary for that, and a student should get it by watching the experiments of others. A teacher should be able to show his students methods of thought and the student should learn how to correlate data and bring them together.

As a conclusion, I would say that the idea of stimulating the originality of the superior student is of the greatest importance. It is not desirable to look for a best course for all. Individuality should be developed in the greatest possible way.

ADDRESS OF G. S. RUTHERFORD

In presenting some thoughts on the training of the chemist-elect, the background of my remarks will be the needs of the Western Electric Company. This organization, as most of you know, is the manufacturing unit of the Bell Telephone System, and its principal products are the subscribers' telephone which are in most of your homes and offices, the central office equipment and the interconnecting wire and cables with the associated loading and repeater equipment. As regards actual production the Manufacturing Department is organized in two main branches reporting to the Vice-President in charge of manufacture; these are the Engineer of Manufacture and the Works Organizations. It is the duty of the Engineer of Manufacture to describe and specify the thousands of items of raw material which enter into the product, to develop the methods, and design and make available for manufacture the equipment required for the great variety of processes employed in the manufacture of its product. This includes apparatus for testing and inspecting the raw materials, the parts in process, and the finished product. The raw materials and processes having been developed, the manufacturing equipment provided, and the details of manufacture worked out and formally specified by the Engineer of Manufacture, it is the duty of the Works Organization actually to manufacture the products for delivery to the customer.

The organization of the Engineer of Manufacture comprises approximately 2500 engineers, machine and tool designers, and draftsmen, not including the clerical groups, many of whose people are technically trained. Of this number, approximately 1750 are at the Hawthorne Plant at Chicago and the balance at the rapidly growing manufacturing units located at Kearney, New Jersey, and Point Breeze, Baltimore. I have been interested recently in classifying the university graduates of this organization, who are located at Hawthorne, according to their university training and also according to the lines of work in which they are now engaged. This classification is shown on the attached chart. The striking point is that in about forty per cent of the cases these engineers are now engaged in a different line of work than that indicated by the course of study pursued at the university.

Before considering the qualifications which we desire in the chemists for our employ, let me first briefly outline the lines of work which are open in our plants to people of chemical training and which require a fundamental appreciation of the laws of science for successful process development and engineering. There are some 18,000 raw material items entering into our manufacture. They include iron and steels for magnetic parts, tools, switchboard framework, and various structural parts of the apparatus; brass for a variety of blanked, formed, or drawn parts; nickel

WESTERN ELECTRIC COMPANY, INCORPORATED, HAWTHORNE WORKS

Comparison of College Training with Present Occupations in Engineer of Manufacture Organization

College Training	*Present Occupation*														
Course	Total no.	Mec. eng.	Elec. eng.	Ch. eng.	Chemist	Physicist	Met. eng.	Ind. eng.	Ceramic eng.	Acc't-ant	Librarian	Tech. clerk	Tech. ex.	% Not following	% following
Mech. Eng.	206	176	14	1	..	..	..	13	..	..	..	..	2	15	85
Elec. Eng.	145	46	80	..	..	2	4	9	..	..	..	..	4	45	55
Chem. Eng.	52	7	...	25	8	..	10	..	..	..	..	..	1	52	48
Chemistry	38	3	2	14	12	..	2	2	..	..	1	..	1	68	32
Physics	25	6	4	..	..	12	..	1	..	..	1	..	1	52	48
Met. Eng.	11	...	...	..	..	..	11	..	..	..	..	..	..	0	100
Ind. Eng.	12	3	3	..	..	..	..	6	..	..	..	..	..	50	50
Ceramic Eng.	5	1	...	..	..	..	..	..	4	..	..	..	..	20	80
Commerce	10	1	...	..	..	..	..	..	..	9	..	..	..	10	90
Arts	20	8	6	1	..	..	..	2	..	1	1	1	..	...	...
General Eng.	10	6	1	..	..	..	..	2	..	..	..	1	..	...	...
Civil Eng.	7	2	1	..	..	..	1	3	..	..	..	..	..	100	0
Mathematics	9	4	1	..	..	..	..	1	..	1	1	1	..	...	...
Agriculture	6	4	...	..	..	..	..	1	..	1	..	..	..	100	0
Arch. Eng.	1	...	...	..	..	..	..	..	..	1	..	..	..	100	0
Aero. Eng.	1	...	1	..	..	..	..	..	..	..	..	..	..	100	0
Modern Lang.	1	...	...	..	..	..	..	..	..	1	..	..	..	100	0
Pre-Medical	1	1	...	..	..	..	..	..	..	..	..	..	..	100	0
Home Econ.	1	...	...	..	1	..	..	..	..	..	..	..	..	100	0
Structural Eng.	1	1	...	..	..	..	..	..	..	..	..	..	..	100	0
Economics	6	2	...	..	..	..	..	1	..	3	..	..	..	183	17
Mining Eng.	4	2	1	..	..	..	1	..	..	..	..	..	..	100	0
Geology	1	...	...	..	1	..	..	..	..	..	..	..	..	100	0
Total	573	273	114	41	22	14	29	43	4	17	4	3	9	41	59

silver and phosphor bronze for spring materials; paper and textiles for insulation of cable conductors; gums, oils, solvents, and pigments for finishes; resins, waxes, and asphalts for insulating compounds; mica, tissue paper, and tinfoil for condensers; copper, lead, and antimony for cable conductors and sheathing; oils and greases for lubrication and corrosion protection; abrasives; adhesives, heavy chemicals, dyes, rubber, and many others. The investigation of the grades of material most suitable and most economical, the study of substitute materials from the standpoint of quality improvement and economy, and the actual manufacture of many of these products at our own plant open a tremendous field.

A list of the processes which go to make up this line of manufacture and which are of greatest interest from a chemical viewpoint includes the following:

Copper wire manufacture including refining of scrap copper, rolling of the rod and actual drawing of the wire.
Manufacture of sheet brass, nickel silver, and other non-ferrous alloys.
Ferrous and non-ferrous metals casting including die-casting.
Casting, rolling, and drawing of permalloy and other magnetic materials.
Welding, soldering, hot tinning, and galvanizing.
Heat treatment of ferrous and non-ferrous metals.
Manufacture, use, and recovery of precious metal alloys.
Application of protective finishes.
Electro-plating of zinc, copper, nickel, chromium, gold, and tin.
Manufacture and application of lacquers, paints, japans, and varnishes.
Phenol fiber manufacture and plastic resin molding.
Hard rubber manufacture.
The manufacture of carbon products, including granular carbon for transmitters, carbon filament resistances, and carbon blocks for protector apparatus.
Flameproofing, dyeing, and waterproofing of textile materials; also special purification processes for textiles used for insulation.
Manufacture of insulating and sealing compounds.
Wire enameling and special insulations for telephone conductors.
Drying of telephone cable and other apparatus.
Manufacture of special glasses, ceramic, and vitreous enameled parts.
Manufacture of switchboard lamps.
Recovery of scrap, lead, copper, paper, and solvents.

In most of these processes there is an important place for the chemist or chemical engineer. Also, it will be understood that the engineer who will be able to carry the greatest responsibility for any one of them is the one who, in addition to his chemical training, has the broadest foundation to enable him to undertake any or all of the engineering phases of the project.

Referring again to the chart and considering the chemists and chemical engineers in one group as classified by training, you will notice that in approximately sixty per cent of the cases the present occupation is

in fields of varying degrees of divergence from the university work, in many of which fields chemical knowledge does not seem to be of primary importance. It is also true that many jobs in which a knowledge of chemistry is important are under the direction of engineers whose university training was classified as mechanical or electrical. The reason is that when important new projects were to be engineered the work fell to the men available at the time who had the best all-round qualifications, although some of these qualifications would not primarily be expected considering the university courses pursued. No doubt the development problems for which these men are now responsible are in most cases very far removed from the pictures they had of the work they would eventually be doing, and it is equally likely that their present undertakings are a long way from the work their employer had immediately in mind when they were hired.

All of this brings us to the main point which I wish to make; namely that the Western Electric Company generally prefers engineers with a sufficiently broad fundamental training to enable them to undertake a wide variety of problems. Usually the new employee is not of greatest interest because of his knowledge in any highly specialized field of engineering which he has undertaken while in the university, particularly if he has had only a four-year course. His formal education is either a point of departure or at most only one step toward his goal.

There are many things which we would desire from a man's university training, but unfortunately much of what is desirable must be sacrificed in the limited time available. First, I suppose we would like him to have an historical background which would help him to orient himself in the twentieth century; we would like him to appreciate the long fight of the race for intellectual freedom; we would like him to be helped to an open mind by a knowledge of the great battlefields of science with ignorance and superstition down through the ages; we would like him to appreciate the freedom of the present day, the fullness of his opportunities and his responsibility for measuring up to them.

Since his mind is his principal tool, it is most important that he know as much as possible of the way it works and that he be trained in its use. He should study psychology. He should gain a mastery of the fundamentals of science—mathematics, physics, chemistry, mechanics, etc.—and finally, in so far as he has time, we would like him to acquire an engineering training which will enable him to apply his scientific knowledge to the solution of the problems of industry. This places the emphasis on the trained mind and on the fundamentals rather than on a highly specialized course because we realize that it is only possible to get a limited amount in a given time and because the student has a lifetime before him for increasing his knowledge and learning to apply it; also because in our

industry, as has been pointed out, we need the flexible type of man. This does not mean, however, that we are out of sympathy with an endeavor to acquaint the student as well as may be with the working conditions and problems of industry at the time he is pursuing his university education. We consider it highly desirable that he have some actual contact with industry during his university course—certainly enough to get his hands dirty. For our purposes it seems sufficient that such knowledge be gained by summertime employment. This contact should help him to realize one very important point aside from his technical training; namely, the value of being able to properly present an engineering project, the importance of selling his work, if you will. It is not sufficient that the engineer do the technical part of the job. He should also be able actually to bring his undertaking to a conclusion—to cash in on it. He must be able to present his facts in a convincing manner before he can secure the necessary funds for his undertaking. Having carried through his investigation and translated it into an actual working process, there is somewhere a board of directors or an executive who will require a clean-cut statement of the results accomplished before they will be willing to appropriate funds for the next project. Further, there is usually a large number of other individuals and groups whose coöperation must be enlisted before he can see his engineering translated into a manufacturing plant and a going process. He must cultivate a forceful and pleasing personality and have the ability to fit into the large social group of varying functions, responsibilities and interests which go to make up the modern industrial concern. I believe this point can scarcely be over-emphasized in these days of highly specialized and functionalized organizations.

All of this, I suppose, simply says that we desire in the engineers who come to us from the universities, men of intelligence, imagination, and background, whose training has given them an open mind and the ability to think clearly; men who have spent their four or five or whatever number of years of university training in acquiring a fundamental knowledge of their science and of engineering; men who know and appreciate other men and whose methods of approach and agreeableness of manner will enlist the coöperation of other members of their engineering and business organization, whose services also are necessary to the success of the industry and of all who are engaged in it.

REMARKS OF W. J. MARSH*

A great many things that I wanted to say, Dr. Langmuir has already said. This is no more than can be expected when we consider that the

* Mr. Marsh kindly consented at the last minute to substitute for Dr. Webster N. Jones who was scheduled to take part in this symposium but was unable to attend.

various organizations which we represent are all confronted with the same problem—that of picking chemists for the job to be done. I shall not burden you with repetition, although some of the ideas brought before you this afternoon are indeed worthy of it, but shall run through a few additional ideas I have concerning the selection of the chemists for industrial work.

In the first place, what outstanding qualification do we consider first when a man comes to apply for a job? I have made it my business during the past few days to put this question to several of my industrial friends here. The diversity of replies greatly surprised me. A few examples will suffice.

The first man considered good appearance. He explained that the chemists who came to him were, in a short period, to graduate from chemical work into either sales or plant foreman jobs, and that he needed men who appeared well. Another man trusted his first impression, gained from a lengthy interview. A third considered first: "Does he show a very evident willingness to work hard?" A fourth wanted an individual who was obviously aggressive. And still another wanted a man possessing cooperative spirit.

These opinions of industrial men are not as far afield from the problems of our teachers of chemistry as they might appear. Our teachers are frequently asking us what it is that the industries want in men. I am reminded of a recent visit to our company of Professor Charles Kraus of Brown University, who has been visiting industrial concerns over the country trying to get a concrete answer to this very question.[1] The reply of the industries represented at that particular conference may be briefly summarized as follows: "We are not so much concerned with what courses the men have had. What we want is men who can think. If their preparation is inadequate in the particular line in which we may want to use them, and if they are men of the caliber we're after, they'll master that subject."

To the opinions of others regarding the first qualification required of a prospective employee, I should like to add my own. I want a man who primarily will give me assurance that he is intellectually honest. If he is not that, he is, in my opinion, absolutely useless in every other way. The university teachers should very early do those things which D. Langmuir has been talking about. They should get into the mind of the young man or the young woman starting out in chemistry the right conception of what it is all about, what they are trying to do, and that he or she should be as honorable in the laboratory as on a tennis court. Any one who would cheat on the tennis court would be sneered at, and yet, in many of our universities we find students boasting of their ability to outwit the

[1] See "Training Chemists for the Industries," by C. A. Kraus and S. T. Arnold, THIS JOURNAL, 6, 852–7 (May, 1929).

professor. That is not honest. That intellectual honesty is sometimes a difficult thing to discover but it is worth seeking. In some cases it is possible to teach an individual to comprehend its full significance.

Perhaps the experience of a friend of mine will clinch this point. Upon being scheduled to teach qualitative and quantitative analysis one year, he found that he had to learn it all over again. As a student he had taken courses in both subjects, but his method of study had been this. When an unknown was assigned, if it was brown crystals, the reagent shelves were immediately searched until a labeled bottle containing similar brown crystals was discovered. That is intellectual dishonesty. If a student is taught from the beginning to be dishonest, he will be of very little future value.

Other qualities such as alertness and determination to accomplish the task at hand are to be considered in selecting men for any particular jobs, but I put intellectual honesty before all others.

Ozone Blanket Keeps Upper Atmosphere Warm. Just as one may sleep warmly out of doors under a quilt, or shiver under a sheet, so the upper atmosphere, what scientists call the stratosphere, is kept warm over arctic latitudes by a thicker layer of ozone. This was the explanation for a curious fact that has puzzled scientists, given recently before the American Meteorological Society by Dr. W. J. Humphreys of the U. S. Weather Bureau.

The stratosphere is the layer of the atmosphere above the highest clouds, and, unlike the lower layers, does not become colder with height. Temperature observations have been made of this layer by means of small balloons, equipped with recording thermometers. "They reveal the curious fact," said Dr. Humphreys, "that the stratosphere is coldest over equatorial regions and becomes gradually warmer with increase of latitude, the extreme difference being around 35 degrees Fahrenheit—coldest over the warmest earth and warmest over the coldest earth."

Though a full explanation has not yet been made, Dr. Humphreys thinks that it is due to the ozone. Observations have shown that there is less ozone over equatorial than over arctic regions, a fact that is itself yet unexplained. But the ozone absorbs radiation from the earth, and reradiates part of it back again. Therefore, where there is more ozone, more heat is sent back, and so the upper atmosphere there is warmest.—*Science Service*

Wood Alcohol Blindness Needs Further Study. The story of the blindness that comes from wood alcohol has not yet been completely told. A further study of this problem might well be made by the newly dedicated Wilmer Ophthalmological Institute at Baltimore, Dr. George E. DeSchweinitz, of the University of Pennsylvania, suggested in his address at the dedication exercises.

Physicians now generally believe that it is not the wood alcohol but some impurity in it, possibly fusel oil, which is nearly always found in commercial wood alcohol, that causes the blindness. The bad liquor prevalent in recent years often contains wood alcohol and has been the cause of much wood alcohol poisoning and blindness. However, wood alcohol may also be inhaled or it may be absorbed through the skin. This is an important hazard in certain industrial operations.—*Science Service*

THE MOORE LABORATORY OF CHEMISTRY AT AMHERST COLLEGE[1]

Evidences of the progress of science in this twentieth century continually arrest our attention. Not the least among these are the numerous recently erected and modernly equipped academic chemical laboratories.[2] Our educational institutions are apparently realizing their responsibility in training scientific leaders.

During the last century Amherst College, with but meager equipment in the earlier days, but always cognizant of the value of science in a "classical education," has supplied to the universities chemistry teachers of whom she can be justly proud. The Moore Laboratory of Chemistry, formally dedicated on October 25, 1929, indicates that Amherst purposes to carry onward the work it has in the past so ably performed.

Order of Exercises

The program on the occasion of this dedication was as follows:

9.30–12.30. Reception and registration of guests at the Moore Laboratory. Inspection of building and equipment.

12.30. Luncheon for guests at the Phi Kappa Psi house.

2.00. *Dedication of the Moore Laboratory of Chemistry.*

Introduction. ARTHUR STANLEY PEASE, *President* of Amherst College.

Address of Presentation. MRS. WILLIAM HENRY MOORE.

Acceptance for the College. GEORGE ARTHUR PLIMPTON, *President* of the Board of Trustees.

Acceptance for the Department. HOWARD WATERS DOUGHTY, *Chairman* of the Department of Chemistry.

Description of the Building. JAMES KELLUM SMITH, member of the firm of McKim, Mead and White, architects.

Address. "The Events That Really Matter." CHARLES EDWARD KENNETH MEES, *Director* of the Eastman Kodak Company.

Presentation of a Portrait of William Henry Moore.

Address of Presentation. GEORGE ARTHUR PLIMPTON, on behalf of the donor, DWIGHT WHITNEY MORROW.

Unveiling of the Portrait. WILLIAM HENRY MOORE, II.

Acceptance for the College. ARTHUR STANLEY PEASE.

Announcement was made at this time, on behalf of Mrs. William Henry Moore and her sons, Edward S. and Paul, of an endowment for the labora-

[1] The material in this article is taken largely verbatim from the pamphlet issued by the Chemistry Department of Amherst College on the occasion of the dedication of the new chemistry laboratory, October 25, 1929. For the accompanying illustrations we are indebted to Professor Joseph S. Chamberlain of Massachusetts Agricultural College, Amherst, Mass., and to Professors A. J. Hopkins and Howard W. Doughty of Amherst College.

[2] See "The R. E. Olds Science Hall at Kalamazoo College," W. C. Johnson, THIS JOURNAL, **6**, 1304–9 (July-Aug., 1929); "Princeton's New Chemical Laboratory," Wm. Foster, *Ibid.*, **6**, 2080–96 (Dec., 1929); "University of Chicago," *Ibid.*, **7**, 210 (Jan., 1930); "Madame Marie Curie Dedicates Hepburn Hall of Chemistry at St. Lawrence University," *Ibid.*, **7**, 268–76 (Feb., 1930).

tory of $250,000. This endowment is in addition to the gift of the building and equipment, which totaled half a million dollars.

William Henry Moore

William Henry Moore, in whose honor these gifts were given, was at one time a student at Amherst. He was born in Utica, New York, October 25, 1848, and died, after a brief illness, in New York City, January 11, 1923. He was educated in a seminary at Oneida, after which he finished a course at Cortland Academy and in 1867 entered Amherst College. He was not graduated with his class, since he was obliged to leave college and travel on account of his health. He became interested in law and devoted his energies to its study. Combining marked natural sagacity with an intimate knowledge of fundamental and statute law, he was eminently successful in practice, and his firm won great distinction as corporation lawyers, acting as counsel for many great corporations. Brilliant though he was as a lawyer, his greatest fame came to him as an organizer of large business interests, and in this field he demonstrated rare genius. Among his greatest successes was the formation of the four great corporations known as the "Moore Group"—since merged with United States Steel Corporation—with a combined capital of $187,000,000. He was at various times effectively concerned in the promotion of such important organizations as the Diamond Match, National Biscuit, American Tin Plate, and the American Steel Hoop companies. From the long list of his directorships may be mentioned those of the Delaware, Lackawanna and Western Railway, the American Cotton Oil Company, the First National Bank of New York, and the American Can Company.

WILLIAM HENRY MOORE

Though deeply engrossed in his business, Mr. Moore yet had time for sports. He was known internationally as a breeder and exhibitor of thoroughbred horses. Nearly all the horse shows in this country, and many of those staged abroad, had his entries, and his fine hackneys were frequently winners of trophies and blue ribbons.

In donating the new laboratory of chemistry to Amherst College the members of Mr. Moore's family are continuing the benevolence that was his

constant practice. It is peculiarly appropriate that the building should have been dedicated on the anniversary of his birth.

Historical Sketch

As there has been, heretofore, no written history of the department of chemistry in Amherst College, the following brief sketch seems appropriate.

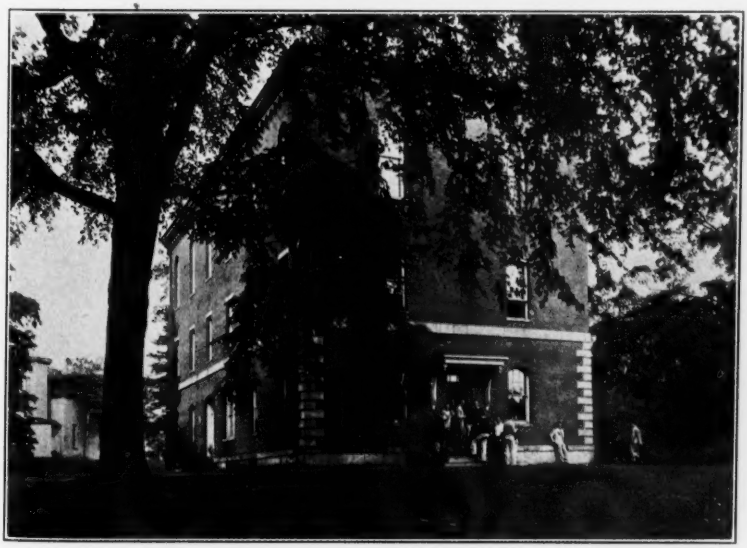
When Amherst College opened its doors to students in 1821, the hopes and purposes of its founders, their devotion and determination, had already, three years previously, been made known to the world in a document called the "Charity Fund," the object of which was to raise "at least fifty thousand dollars for the purpose of establishing in Amherst, in the County of Hampshire, an institution for the classical education of young men of hopeful piety and talents to prepare them for the Christian ministry, in view of civilizing and evangelizing the world."

EDWARD HITCHCOCK
First professor of chemistry at Amherst. Appointed in 1825.

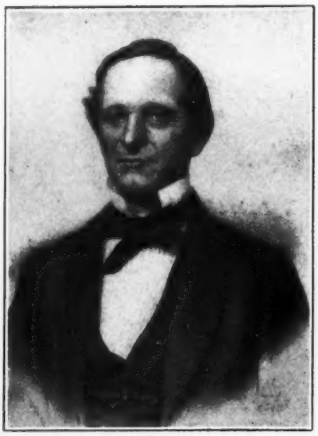
It would seem, however, that the definition of a "classical education" was a very broad one for that day. In the earliest statement of courses we find a single science, which was chemistry, offered (by lectures to all classes); and by 1827, physics, mineralogy, botany, engineering, and architecture appeared in the curriculum, in addition to chemistry. By the time a charter was secured from an unwilling legislature in Boston in 1825, the first professor of chemistry was appointed. This was the revered and Reverend Edward Hitchcock. His salary was only seven hundred dollars; but with characteristic activity, on completion of the Chapel in 1827, he established his department in the basement of that building—the first laboratory of chemistry in the new college, and here the department remained for thirty years, "so long," says the historian, Tyler, "the scene of Professor Hitchcock's brilliant experiments and coruscations of genius."

The fame of the college spread rapidly, so that in 1836 the number of students enrolled surpassed that of any other New England college, except Yale. Hitchcock's reputation as a broad scientist grew, not in chemistry only, for, while he was accepted as an authority in astronomy and biology, his fame in geology became international. Yet he remained in the department of chemistry until his election as "president of the college and professor of natural theology and geology" in 1845.

JOHNSON CHAPEL—REAR
In the basement of this chapel Hitchcock established his first chemistry laboratory. These quarters were occupied for thirty years.



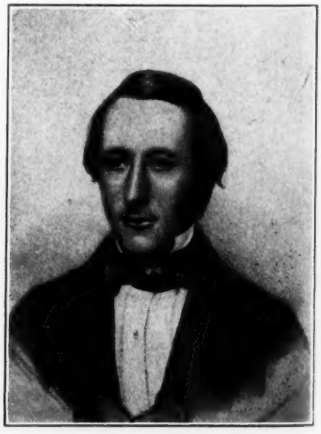
WILLISTON HALL WHICH HOUSED THE CHEMISTRY DEPARTMENT FROM 1857–93



CHARLES UPHAM SHEPARD
Successor to Hitchcock as professor of chemistry.

His successor was Charles Upham Shepard, of New Haven, a graduate of Amherst in 1824, who had been professor at Yale and at the South Carolina Medical School. About this time a grant of twenty-five thousand dollars was secured from the legislature and this was applied as an endowment to the chair of chemistry, so that the title in 1848 and until Professor Shepard's retirement, was "Massachusetts Professor of Chemistry." Shepard was a noted mineralogist, and it was he who enriched the college by gifts of the well-known collections bearing his name. He resigned in 1854, but continued on the faculty as professor of natural history until 1877, and as professor emeritus until his death in 1886.

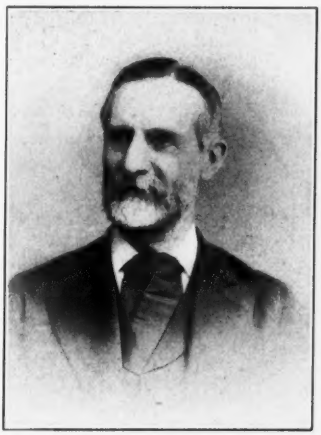
Up to 1839 chemistry was taught by lectures and recitations only, but at that time recitations and possibly individual instruction to special students were provided in the laboratory. During the last year of Shepard's incumbency, 1853–54, his successor joined the department. This was a young man of the class of 1848, William S. Clark, the first graduate of the college to receive a doctorate in chemistry from a German university. In 1857, the department left the basement of the old chapel, "which in 1827 seemed so ample and magnificent and was in fact in advance of the laboratories in other and older colleges," and found new quarters on the first floor of Williston Hall—this new laboratory being "fitted and furnished by the wealth and liberality of Mr. Williston, to satisfy the demands of Professor Clark, young, ambitious, and fresh from the laboratories of Europe."



WILLIAM SMITH CLARK
First professor of chemistry in the quarters in Williston Hall.

Here the department was destined to remain for thirty-six years, until 1893. In 1853, Professor Clark had brought with him his fellow-student in Göttingen, J. W. Mallet, of Trinity College, Dublin,

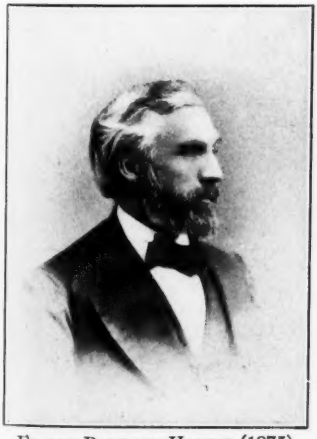
who remained until 1856 as professor of analytical chemistry. On leaving Amherst, he was called successively to the universities of Louisiana, Texas, and Virginia. During the Civil War he served as superintendent of ordnance in the Confederate army, and in 1882 was president of the American Chemical Society.



JOHN WILLIAM MALLET
Clark's fellow-student at Göttingen and colleague at Amherst.

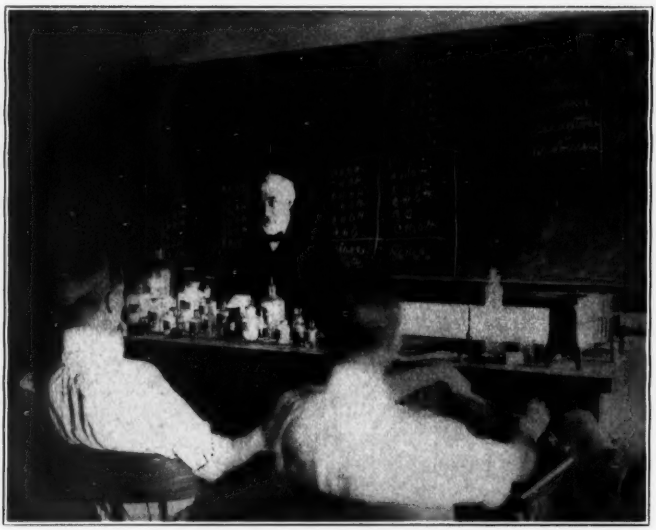
On the other side of the great conflict, Professor Clark joined the Union army in 1861 as major—afterward as colonel—his work being ably carried the first year by Instructor Newton S. Manross. Clark was eventually disabled and remanded home, and Manross, who had joined him in 1862, fell at Antietam. Clark resigned in 1868 to accept the position of first president of the Massachusetts Agricultural College.

It was in this same year, 1868, that Elijah Paddock Harris, of the class of 1855, then professor at Beloit, was called to Amherst. Authority was given him to spend a sum "not exceeding fifteen hundred dollars in refitting and refurnishing the laboratory," and plans were laid for the extension of the chemical curriculum beyond the one-year course.



ELIJAH PADDOCK HARRIS (1875)
During his regime chemistry instruction was offered for the first time to the lower classmen.

The first definite notice in the catalog of laboratory instruction for the individual student appeared in 1855, under Clark and Mallet. Until 1868 all instruction in chemistry had been offered to juniors only, but in this year, the first of the Harris regime, elementary instruction was offered to sophomores, thus clearing the decks, but it was not until 1873 that a second course, organic chemistry, was available to juniors. Laboratory instruction of the entire classes, as distinct from classroom work, was begun in qualitative analysis shortly after Leverett Mears (later of Williams College) joined Harris in 1876.



PROFESSOR HARRIS IN THE CLASSROOM

FAYERWEATHER LABORATORY WAS COMPLETED IN 1893 AND IS STILL IN EXCELLENT CONDITION

Clark was the first graduate of Amherst to complete his chemistry course under Wöhler in Göttingen. Mallet, Manross, and Harris came to Amherst from the same laboratory. The list of those continuing in graduate work after their course in Amherst is an honorable one.

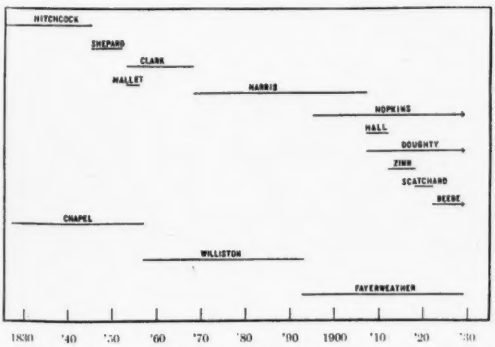
The modern period begins in 1893, when the Fayerweather laboratory was completed. Professor Harris continued as head of the department until 1907, his incumbency lasting thirty-nine years, a period exceeding that of any of his predecessors. The courses offered in 1907 were general chemistry, qualitative analysis, quantitative analysis, and organic chemistry (by lectures), each course lasting a year.

PROFESSOR HARRIS IN 1911

In 1907, after thirty-nine years of service, Professor Harris retired.

It is to be noted that of the laboratories, the first—in the chapel—was in use thirty years, while the Williston and Fayerweather laboratories have each served thirty-six years. Must we then judge from this record that the life of a laboratory is only one-third of a century? Or are there causes exterior to the building itself which have brought about these comparatively rapid changes? The latter would seem to be the case. The Fayerweather laboratory, after thirty-six years, is still in excellent condition and will give many more years of useful service for other purposes.

There has been compiled recently for the Alumni Council a table of the number of students attending the different courses in the department for the past twenty years, showing the steady increase in attendance. A similar record would doubtless be found duplicated in other colleges, reflecting, as is well known, the increased interest in chemistry in the world at large. With the registration



CHRONOLOGICAL CHART

Professors of chemistry above, laboratories below.

of students nearly double that of 1892–93, and rapidly increasing in the past few years, and with the demand for new courses and for rooms for research work, we needed no prophet to read for us the handwriting on the wall. In fact, the necessity for larger quarters, the inadequacy in size of the Fayerweather laboratory, was so evident that the department looked forward with fear for its success as it faced the opening of each new year.

Barnes, Amherst, Mass.

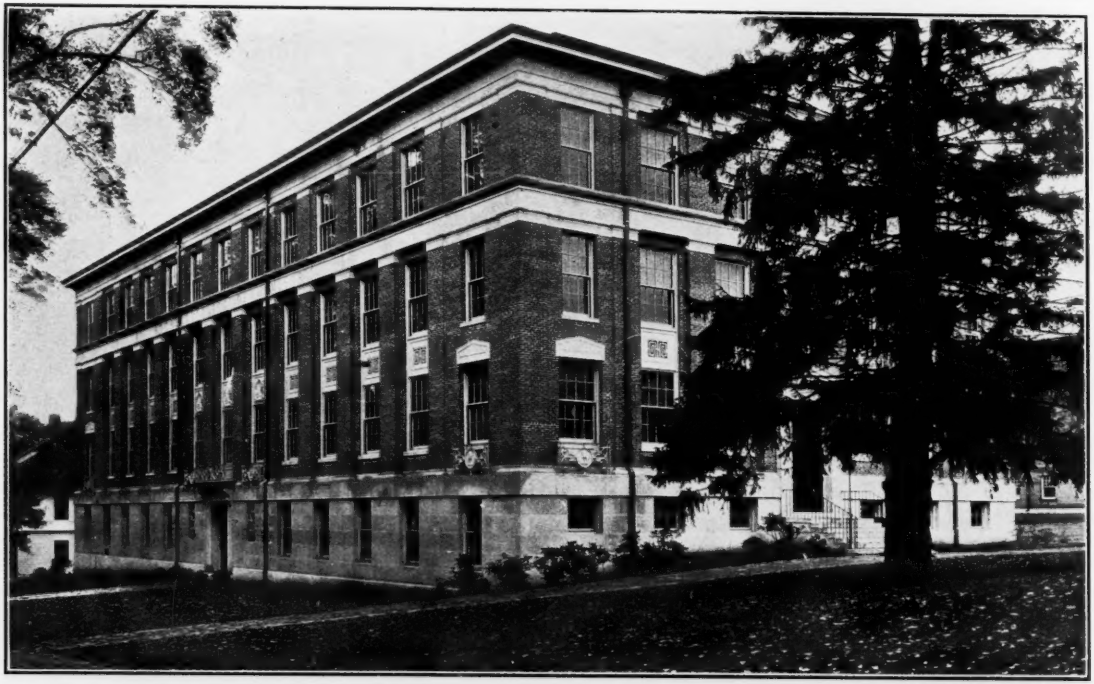
MAIN ENTRANCE TO THE MOORE LABORATORY

The gift of the Moore family to the College and to the department has therefore come most fortunately—doubly so in its anticipation of the impending need. The broad generosity which called for liberal quarters and was unsatisfied with anything short of perfection in detail has made it possible to plan a laboratory of excellent construction and capable of caring for the physical growth of the department.

The new laboratory provides also an opportunity for immediate growth of another kind, not in numbers but in inspiration, because the private laboratories, here provided, will encourage the staff and advanced students to press forward in their scientific research—the greatest inspiration of the true chemist.

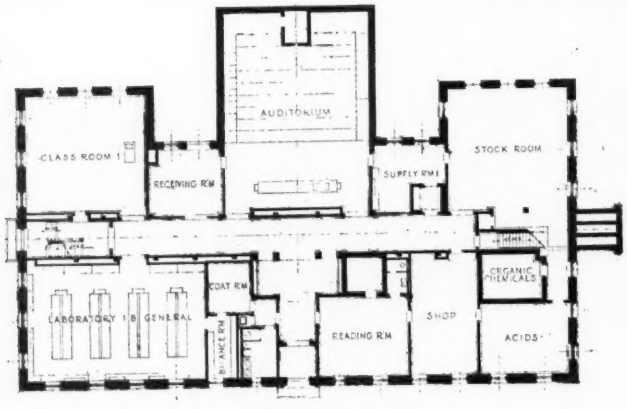
Description of the Laboratory

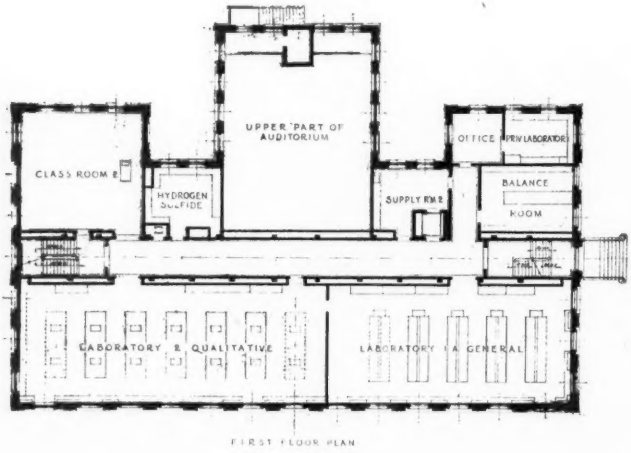
The trustees selected, as the location for the new laboratory, ground facing College Street near the Fayerweather building. The structure com-



Barnes, Amherst, Mass.

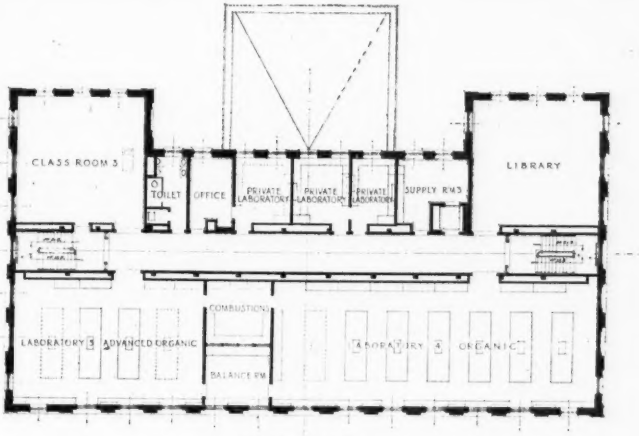
MOORE LABORATORY DEDICATED OCTOBER 25, 1929





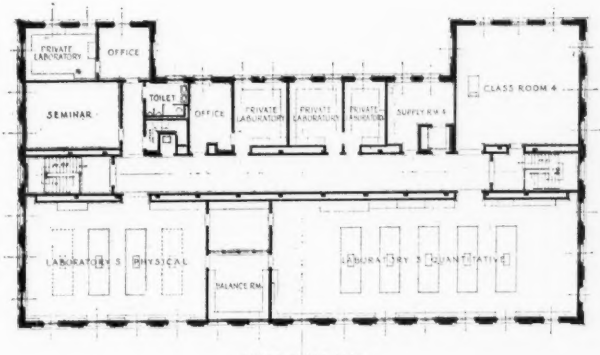
prises a basement and three stories, 140 feet long, 60 feet wide, and about 60 feet high, giving a total area of 32,000 square feet on the four floors, all of first class, fire-proof construction. The outer walls are of concrete and New England water-struck brick, trimmed with Indiana limestone, the floors of reinforced concrete slabs finished with rubberstone, the columns and floor beams being of steel.

As one enters the building from the north, directly opposite, at the end of the short vestibule, hangs a portrait of Mr. Moore in whose memory this



SECOND FLOOR PLAN

AMHERST COLLEGE CHEMISTRY BUILDING
AMHERST MASS



THIRD FLOOR PLAN

building has been erected. The portrait is by Mr. Ercole Cartotto, and is the gift of Mr. Dwight W. Morrow.

In the following description, a few details of construction have been chosen for special mention. The large laboratories, two on each floor, have been placed on the north side, in order to have the advantage of a steady light. Moreover, since the demand for size in these student laboratories is likely to vary from time to time, some flexibility is desirable. For this reason, the partitions between the two laboratories on each floor are of temporary construction.

In general, the rooms are 11 feet high, with walls of plaster, painted with acid-proof paint, and the "trim" of stained and varnished birch. The college central heating plant furnishes steam under thermostatic control. A unit system of ventilation—the Univent system—supplies each room with fresh, heated air. Each large laboratory is provided with exhaust ventilation through the hoods, the unit fan for this purpose being located in the attic and controlled by a push button in the corresponding laboratory.

Drainage in a chemistry building is most important. On the north side, all the soil pipes are of Duriron; on the south side, where the smaller laboratories are placed, the lengths are of cast iron, soil pipe, with bends of Duriron.

The plumbing equipment, besides drainage, consists in the installation of cold and hot water and steam supplies, gas, and compressed air. On the desks, in some laboratories, hot water is also secured by steam-mixers. Compressed air is obtained from a compressor in the sub-basement; and vacuum from individual water pumps on the desks.

Electric service consists of lines for alternating and direct current, the latter being distributed and the voltage determined by switch boards in various locations, the Standard Electric Time Company of Springfield, Massachusetts, being the contractors for all this equipment. Beneath the rising seats of the auditorium, are two small rooms, the inner one containing the heavy line switches—and the outer containing the room- and motor-switches (for the 110-volt and 220-volt currents) and also the direct-current installation. The latter consists of a motor-generator for the 110-volt line, and Tungar rectifiers and storage batteries for low voltage.

All the desk tops are of alberene stone and the hoods of transite asbestos. A house telephone connects all rooms. An automatic lift, serving all four floors, is so placed that it may be entered, at each landing, either from the corridor or from the supply room.

A corridor, running east and west on each floor, divides the building into two portions. Of the class laboratories on the north, two for elementary chemistry [Chemistry I (A) and I (B) and that for Chemistry II (Qualitative Analysis and Inorganic Preparations)] are placed on the lower floors. This arrangement secures quiet for the advanced classes (Organic and Advanced Organic Chemistry and Quantitative and Physical Chemistry) on the second and third floors.

No detailed mention of each room is necessary, since a glance at the plans will show the arrangement, but a few notes follow concerning certain selected rooms.

The main supply room adjoins the curator's suite (office and laboratory) on the first floor and the lift connects all supply rooms, of which there is one on each floor. In the basement, the supply room, the stockroom, the acid room, and the vault for organic inflammables are so interconnected

that the curator, in the ordinary pursuit of his duties, need never step outside of these rooms.

The auditorium, opposite the main entrance in the basement, is a hall 62 feet by 40 feet and 26 feet high. The rising seats number one hundred and fifty three.

There are four classrooms, one on each floor, each seating forty-eight.

For study, there is a reading room in the basement for students, a department library on the second floor, and a seminar room on the third floor. The library is about 30 feet square and contains books and journals for immediate use, removed from the main college library and placed in care of the department.

Special mention should be made of the supply and tap room for hydrogen sulfide. This room, directly opposite the laboratory for Qualitative Analysis, is constructed as a large hood, with a ventilating system of its own. In one corner is a generator, designed by Professor Doughty of the chemical staff—an apparatus of stoneware, of very moderate cost, so automatic and self-cleaning that (if an experience of about twenty years can be trusted) it need never be opened, except once a year for recharging. Near-by, also, is a carbon dioxide generator, working on the same plan and principle; and against three walls of the room are students' supply taps for each of the generators. The pipes for hydrogen sulfide are of aluminum with rubber connections to hard rubber stopcocks.

On the second and third floors are three suites (each comprising office and private laboratory) and four small laboratories, for special work by members of the staff.

In planning the building, the staff and the architects have kept constantly in mind that the purpose of this laboratory is the teaching of chemistry in a small college. Of paramount importance to this end is the provision of adequate space so that each class may have its separate quarters while ample room remains for the carrying on of private work by advanced students and members of the department. We trust that this object has been attained in the present structure, and that the Moore Laboratory will continue for many years to come to serve the needs of our students by giving them that fundamental preparation in science which, as educated men, they will be called upon to apply to the problems of modern life.

Says All Scientific Work Not Mathematically Exact. The old belief, widely held at the beginning of the recent great industrial development, that all science could be calculated with mathematical exactness no longer holds true, W. A. Shewhart, of the Bell Telephone Laboratories, believes. Scientists now do not expect to make a thing exactly as they want it and will revise their methods to make better use of this new knowledge.—*Science Service*

THE CHEMIST AS AN EXPERT WITNESS

WILLIAM M. DEHN, UNIVERSITY OF WASHINGTON, SEATTLE, WASHINGTON

Need for Information

At times perhaps no other activity of the chemist is more important, requires more varied and thorough preparation, and yields more dramatic interest and lasting satisfaction than that of the successful expert witness. Too often, however, though on the equitable side of the case, though possessed of adequate skill and knowledge of his science, though satisfied with his preparation for the case, and though possessed of a balance of tactful and combative qualities so necessary for court success, his experience there may develop mortification and regrets that will endure for years.

When the witness has been provoked, confounded, frustrated, detected in untruths or in half-truths, or otherwise outwitted, discredited, and routed, he may learn afterward that his partial or preponderating failures resulted from a variety of causes. Chief among these[1] are: his unfavorable personality, his faulty enunciation and diction, his timidity or irritable temper, his dogmatic or conceited attitude, his lack of knowledge of human nature and of legal evidence as applied to the expert witness,[2] his confusion, obscurity, and inaccuracy in answering categorical questions, the omissions and errors of his own lawyer, and, saddest of all, being caught in traps set by the opposing lawyer.

"When proof is necessary under legal rules, and always against opposition, something more than technical knowledge is necessary." In the battle for the substantial equity or damages, in the battle for the life or liberty of the defendant, the academic attitude will not suffice. *Per se*, no array of university degrees, or of learned scientific publications, no national professional prestige, no lofty character or scholarship, no natural dignity, fairness, and seriousness will immunize or protect the expert from the bullying, the indignities, and the traps of cross-examination. The battle is on and, though he has qualified as a specialist, he may not be an expert witness.

Concerning the methods employed in cross-examination, "They were succinctly stated nineteen hundred years ago by the Dean of the Roman Law School, Professor M. Quintilian, as follows: 'If the witness is timid, he may be frightened; if, foolish, misled; if irascible, provoked; if vain, flattered; if prolix, drawn from the point; if, on the contrary, a witness is sensible and self-possessed he may be hastily dismissed as malicious

[1] See Osborn, "The Problem of Proof," Matthew Bender & Co., New York City, **1922,** in which certain chapters are devoted to the expert witness. See also books on legal medicine, etc.

[2] See especially H. W. Rogers, "The Law of Expert Testimony," Central Law Journal Co., St. Louis, Mo., **1891.**

and obstinate or he may be put out of countenance by a jest; or, if anything can be said against his moral character, his conduct may be overthrown on infamous charges."[3]

As was further pointed out by Clark, "For numerous thousands of years the lawyers have been practicing this art of cross-examination. They have written books upon books about it. . . . and you may search the libraries in vain for any book telling about the art of being cross-examined."

Whereas the alienist has been the most frequent expert witness and "is always a welcome guest in the court room,"[4] and whereas there is an extensive literature on medical jurisprudence,[5] we have no direct literature on chemical jurisprudence, or legal chemistry, or collected information that will specifically aid the chemist in preparing and functioning as an expert witness. The need for this information must have been felt by all chemists who have qualified as such, but their own experiences on the stand have not been handed on to others. Certainly no survey and discourse on what the chemist would like to know and ought to know in this important service is at hand.

Suggested Outline of Proposed Monograph

The purpose of this article is to indicate the need of a monograph on the title of this paper and to point out the advantage of regulation of fees of the expert witness. The following paragraphs are intended to suggest subject matter for some chapters of such a monograph.

The Experimental Preparation for the Case.—Whereas all cases differ, the experimental work should be complete on the basis of the present chemical knowledge of methods and tests. If possible, new tests and research should be developed to confound the opposing expert and lawyer and to strengthen your own testimony.

Coaching Your Own Attorney.—Most attorneys have little or no knowledge of chemistry. To be most effective it will be necessary to prepare a brief that covers the experimental and literature aspects of the case and it should be written largely in the layman's language. Whereas it is not permissible for the attorney to instruct the witness as to the facts of the evidence, it is permissible and necessary for the expert to instruct the attorney, provided that he does not in court "actively engage in assisting in the case like a lawyer." A series of questions and answers, prepared

[3] See Wigmore on "The Principles of Judicial Proof," Little, Brown & Co., Boston, 1913; Marcus Fabius Quintilianus, "De Institutione Oratoria;" also Clark "Answer Yes or No," *N. Am. Rev.*, July, 1929, p. 85.

[4] Hugo Munsterberg, "On the Witness Stand," The McClure Co., New York City, 1908.

[5] For a bibliography of medical jurisprudence and expert testimony, see Wigmore, "On Evidence," 1, 966, Little, Brown and Co., Boston, 1928.

by the expert, bearing on the case and covering all anticipated questions on the direct, the cross-examination, and the rebuttal, should be prepared and should be included in the brief. These should be studied by the attorney, and selection from them should be made on the basis of relevancy, permissibility, etc. They should be rearranged, revised, and amplified, until the sequence and scope have been determined. If practicable, when the case is on, a transcript of the court record should be studied by the expert for the following day's testimony. Also, during recesses, written questions and answers for rebuttal of the opposing testimony should be prepared for the attorney.

Qualifying as an Expert Witness.—"An expert is one who is skilled in any particular art, trade, or profession, being possessed of peculiar knowledge concerning the same."[3] According to this legal definition any teacher of chemistry or graduate chemist, especially of the rank of Ph.D., being "skilled in acquiring accurate conceptions" of the science, is qualified to become an expert witness. However, no chemist is qualified on all subjects of chemistry; he must prepare specifically for each case. A chemist does not know all about chemistry; a lawyer does not know all about law. On taking the stand, "The experiential qualifications of a witness are usually established by his own testimony reciting the facts of his career and special experience." Prepare for the case, establish your qualification, and keep the cross-examination within the limits of your qualification—such as a toxicological chemist, industrial chemist, etc. Be alert to prevent being drawn into collateral sciences or chemistry for which you had not especially prepared by saying, "I did not qualify as a physician, as a food specialist, etc."

Demonstrations in Court.—In most courts the witness is permitted to illustrate his testimony on a chart and to make chemical demonstrations. Even simple chemical tests have won cases. The handbag and pockets should contain apparatus and materials for anticipated and impromptu demonstrations. Use your own stuff and be prepared to test the opponent's. Be thoroughly prepared on all systems of weights and measures and have present your own cylinder graduate, spoon, microscope, syringe, etc. Demonstrations alone are not sufficient; the accompanying discourse should be clear, concise, and convincing. Because after-thoughts usually suggest many things that might advantageously have been said and done, great ingenuity and preparation are necessary for complete success.

Conflicts of Experimental Evidence.—It is well known to the chemist that most tests, under some conditions, may be interpreted erroneously. Indeed, it may be held that every test, under some unfavorable condition or through erroneous inference, can lead to fallacy. The expert chemist anticipates these errors and guards himself against such misinterpreta-

tions. However, some tests, as reported by prior investigators, are inherently fallacious but were not so recognized by the early investigator. The later investigator will either adopt those tests on faith or he will reinvestigate the tests and will detect the fallacy. For example, it was known for years (Otto's test of 1846) that strychnine can be detected by adding to it sulfuric acid and a crystal of potassium dichromate, when a "fading purple" will result. In a court case in Italy in 1880 it was claimed that ptomains obtained from the cadaver gave the same purple, and that strychnine was not present. The American, Lloyd, found that a mixture of morphine and hydrastine when treated with sulfuric acid gives a color resembling the strychnine purple. Codeine and formaldehyde (embalming fluid) will give a similar purple with sulfuric acid. In one case in the state of Washington, the chemist for the prosecution testified that he found strychnine and recited only Mayer's and Otto's tests. The defense showed that codeine and formaldehyde, which were admitted in the evidence of the prosecution, produced the purple—and the defendant was acquitted. So mistakes have occurred in the work of expert chemists. If your side of the case is equitable, do not hesitate to supply your lawyer with technical information designed to confuse and rout the opposing expert and lawyer.

Books of Authority.—The lay juror is impressed by the printed page. In cross-examination, books are used to controvert books, and to confuse and trap the witness. Subtle partial quotations, obsolete terms, and literature, the printed conflict of opinion, mingling of theories and opinions with established facts and printed misstatements of fact are used to discredit the testimony of the expert. Search will uncover contradictory statements on most subjects. No one has read all pages of chemistry, or of law. There are no absolute authorities in chemistry, even in limited fields. Books are written by experts such as you. If necessary pass judgment on opinions but do not be inveigled into indorsing the entire book. Beware of the question, "Do you consider this author an authority on the subject?" Remember that in all books, "The opinion was not expressed under oath, and may have subsequently been modified. The writer is not present in court; no opportunity is given for his cross-examination and the jury cannot observe the witness."[2] From authoritative books, passages like the following are introduced to discredit the experimental work of the expert, "Is it not true that (quoting from the book) 'no one except the analyst himself should be admitted to the room during the progress of the investigation and under no circumstances should any poison, other than the reagents used in the analysis, be permitted in the apartment?'"[3] The absurdity of these precautions are understood by the chemist. Stoppered containers are more effective than doors in preventing cross-contamination. The poisons in the druggist's apartment do

not contaminate the prescriptions that he compounds. Also note this absurd quotation, "All chemicals used in every operation should be known from actual tests by the chemist himself to be free from all impurity," and the question of cross-examination, "Did you purify each of your reagents?" No chemicals are free from all impurities, and no chemist can, or finds it necessary to, remove all impurities from his reagents for particular tests.

Answer Yes or No.—This type of question is used in cross-examination to confuse and trap the witness. "Is alcohol a poison? Answer yes or no." It must be remembered that answers of "yes" or "no" to scientific questions are frequently inaccurate or impossible. The answer may be "yes" or "no" or "neither" or "both" or "partly yes, partly no, and partly neither." Answer accordingly and quickly state, "I wish to qualify, or explain, my answer." Then discourse at length and, if necessary because of interruption, etc., appeal to the judge for the opportunity to complete your answer. Remember for your own advantage, as was advised by Wellman for the advantage of the cross-examining lawyer, "If you allow the witness a chance to give his reasons or explanations, you may be sure they will be damaging to you, not to him."

The Traps of Cross-Examination.—These lead to false inference, contradiction, misstatement and ridicule of the witness:

Q. "What elements are present in cocaine?"
A. "Carbon, hydrogen, oxygen, and nitrogen."
Q. "And you tested for and found only these elements present?"
A. "Yes."
Q. "Are these same elements found regularly in human tissues?"
A. "Yes."
Q. "That is all!"

Here the witness should have said, "Yes, and I wish to explain my answer"—then he should discourse on the subject and, by indirection, should point out the sophistry involved, for "every real opportunity to confound the examiner should be taken advantage of."

Finally, it must be remembered that "on the cross-examination a witness may be asked any question tending (1) to test his accuracy, veracity, or credibility or (2) to shake his credit by injuring his character, and he may be compelled to answer the same."

Other Subjects.—Other subjects of interest to the chemist about to testify as an expert witness are: the hypothetical question, admissibility of opinions of the expert, impeachments of expert testimony, patent law, bias, and pecuniary subserviency, etc.

From the viewpoint of the court, "Much has been declaimed about the partisanship and consequent untrustworthiness of the usual professional

man as an expert witness." From the viewpoint of the expert witness, "Professional men of honorable instincts and high scientific standards look upon the witness box as a Golgotha and disclaim all respect for the law's method of investigation." In view of the fact that these opposing attitudes of mind exist, whereas it is generally recognized that "the present method has for years exhibited shortcomings which are lamentable" and whereas it is desirable to improve upon the present method, yet little has been attempted for such improvements, and nothing has been done by the chemist for his own betterment as an expert witness.

Fees.—One matter that can be improved or partly regulated is the compensation paid the chemist for service in connection with expert testimony.

It is customary and permissible in most courts to ask the expert, "What fees are you being paid for this testimony?" This question is proposed to disclose prejudice and to discredit the witness. That the fees should be predetermined and should be frankly stated is self-evident.

"Special services other than attendance to give testimony on a trial are not within the duty of any witness, hence a professional man is entitled to demand special compensation." Just what fees should be charged for the experimental work, for the search of the literature, for writing the brief, and for conferences with the attorney are not subject to rigid or final rules. One should not necessarily "charge all that the traffic will stand," nor should one charge less than the customary fees of the competent chemist, certainly he should not charge less than that paid for comparable work of other professional witnesses, such as physicians, alienists, handwriting experts, etc.

The separate *per diem* fee for services on the stand, for the state, is usually regulated by statute. For the defense in criminal cases, and for either side in civil cases, the fee is a matter of contract. Some years ago, concerning the question of compensation to physicians testifying as expert witnesses, Beck[6] observed, "It is quite time that the medical profession in this country should rouse itself to a demand of its just rights." Today the minimum *per diem* fee for medical expert testimony is usually $100. Often the chemists in educational institutions, serving as expert witnesses, through modesty or otherwise, have cheapened their profession by undercharging.

If a special committee of the American Chemical Society could collect the court experiences of chemists, together with suggestions on how to meet unique subtleties of cross-examination, a monograph could be compiled and it would do much to establish the credibility and prestige of the chemist and to promote public justice.

[6] "Medical Jurisprudence," J. B. Lippincott and Co., Philadelphia.

RADIO REACTIONS*

SAUL B. ARENSON, UNIVERSITY OF CINCINNATI, CINCINNATI, OHIO

About a year ago, the University of Cincinnati inaugurated several series of radio talks over WLW, a 50 k.w. station with a nation-wide coverage. There was a talk on science on Wednesday evenings, and one on a cultural subject on Fridays throughout the school year. Each series was made up of five to fifteen interrelated talks, of fifteen minutes' duration, each given by faculty members of the University. I had the privilege of inaugurating the broadcasting program by giving a series of fifteen talks on chemistry under the title, "Taking the *Mist* out of *Chemistry*." These talks were popular in nature and followed the order of a college text on general chemistry, as indicated by a few of the titles: "The Romance of Chemistry," "How Big Are Atoms," "Our Lightest Gas," "The Air We Breathe," "What We Drink," "That Poisonous Green Gas." Some of the talks were monologs, while others were interrupted by an assistant who asked questions. A bibliography was usually appended.

Some of the talks by other faculty members were on "The Drama," "Life in the Forgotten Worlds," "The A B C of South America (Argentine, Brazil, and Chile)," "Representative Americans," "Going to College."

To write a series of talks on science to be read on the radio is a relatively difficult problem, due to the fact that at least fifty per cent of the audience changes from talk to talk. Then, naturally, the audience is of mixed types, including shut-ins, business men, professional men, students, women on the farm, etc. As many as twenty hours were spent in preparation of some of these fifteen-minute talks, in an effort to make them as interesting and educational as possible in order to compete with the temptation to turn to jazz or even shut off the radio altogether. One does not dare shoot too much over the heads of the listeners; otherwise they leave you. Nevertheless one must put in a few new words and terms and thoughts for the audience to carry away. For that purpose I hammered away at catalysts in several talks. I took it for granted that a great many of our technical terms like gas, crystals, and liquefaction were in common usage. Then one has to give a great many items which are already known to the audience in a general way, so that some one in the group of listeners can turn around to the other members in the group and say, "See, isn't that what I said last week?"

We reasoned that if we knew the type of audience we had, we could better arrange our talks. Of course, personal friends told us that they were listening in, but otherwise, except for people who were purposely asked to listen and report as to our diction, speed, enunciation, etc., we had no idea as to the type or extent of our audience. We could, of course, ask for comments from our listeners, but we did not want a large stack

*Paper delivered before the Division of Chemical Education of the A. C. S. at Minneapolis, Minnesota, September 10, 1929.

of purely "fan" mail. So we devised the scheme of mimeographing copies of the talks and announcing at the conclusion of each talk over the air that a copy could be secured upon receipt of a self-addressed long envelope with four cents postage. Notice how relatively difficult we made it for the listener. He had to address two envelopes, one of them a long one, use six cents postage and write a letter. The first week I was gratified to receive eighteen replies. However, the number rapidly increased, over four hundred people asking for copies of the talk on chlorine. All in all, thousands of letters were received from every state east of the Rockies, from eastern Canada, Cuba, and Porto Rico. Radio stations figure that they receive one letter, on the average, for every five hundred listeners to a commercial program, and one to a thousand on an educational program, so figuring very conservatively, as they claim, at one to seven hundred fifty, one is amazed at the possible size of the audience, especially if the station is as prominent and powerful as is WLW.

These thousands of letters were carefully read and answered, taking the full time of a secretary. Roughly one-half of the letters came in with no comments other than that they enjoyed the talk, and having missed out on part of the talk due to tuning in late or static, they wanted a copy to read at their leisure. The other 50% asked questions or were more elaborate in their statements of praise or criticism. These letters were generally from professional men or business men or students or teachers. They told that students were organized in the home or dormitory or fraternity house to listen in. Quite a few of the high-school students mentioned the fact that their teacher gave them extra credit for listening and reporting on the talks. One West Virginia boy even told me that so far I had agreed with the text very closely. I was called upon to advise high-school students as to what to study and read in preparation for college work in chemical engineering or chemistry. I was asked to advise them as to what topic to choose in the A. C. S. essay contest.

As to the business man, a great many of them were business-like, and sent envelopes for the entire series of talks at one time. Should I mention their particular industry, immediately I received a flock of letters from them. My statement of the use of ammonia and sulfur dioxide in iceless refrigerators caused many requests from city and state sales managers of Kelvinators and Frigidaires. Should I talk of mining of salt, I would get booklets from the natural brine, artificial brine, and natural rock salt manufacturers. My talk on chlorine brought requests from many ex-service men who had had first-hand contact with poison gas.

All letters were answered. Some of these letters, of course, were quite amusing, as the one, for example, from a woman in Louisiana who wrote that her husband liked jazz and comedy but just as soon as he went to the barber shop she tuned me in. Or the one from the man in New Jersey

who sent me an air-mail letter stating, "I realize that your talk tonight was on industrial alcohols, but since so much of it has been converted to beverage use, will you kindly tell me the difference between ethyl alcohol and grain alcohol; whether ethyl alcohol has fusel oil in it, and how it may be removed; how to make ethyl alcohol from sugar, etc."

The responses to all radio talks were so spontaneous and generous that the University of Cincinnati has decided to be on the air again two nights a week during the new school year. We are not trying to give courses for credit over the radio. We feel that it is one of the duties of an institution, especially a municipal one, to make every effort at adult education, and one certainly reaches the masses nowadays through the radio. As far as I know, this was the first effort to give a series of connected talks on chemistry on the air, and I hope to complete the set by an additional series this fall on industrial processes, as the manufacture of pig iron, glass, sugar, portland cement, etc. I would like to exchange notes and ideas with any one who has given talks on science over the radio or who contemplates doing so.

Cost of Storing Helium Reduced. An interesting development is the latest method of storing helium gas. This remarkable gas, so essential to the safe operation of our giant dirigibles, is very costly, which, together with the fact that enormous quantities have to be accommodated, presented quite a problem for storage. The solution of this problem was indicated when it became known that the Goodyear Zeppelin Corp. had awarded the contract for their Akron field storage to the A. O. Smith Corp., of Milwaukee.

For some time leading tank manufacturers have wrestled with the question of finding the most economical combination of pressure and size for these storage tanks. The Smith proposal makes possible the storage of gas under pressure at a considerably lower cost than ever before. Briefly it involves a battery of tanks 80 ft. long and 2 ft. in diameter. Two lengths of Smithweld gas line pipe are joined and heads welded to the ends to make up each tank. Thanks to the high-tension steel used and the 100 per cent efficient joints, it is thus possible to employ comparatively high operation pressure and consequently a favorable ratio between volume and weight; yet it is unusually low in cost.

For the Akron Zeppelin Dock it was desired to maintain a storage capacity of at least 1,000,000 cu. ft. of dischargeable gas, which is approximately the volume of one cell for the new 6,500,000 cu. ft. ships being built for the U. S. Navy. Ninety-six tanks of the Smith design will be supplied to take care of this storage. The tanks will be buried underground and suitably manifolded together in groups.

That this new method of gas storage has found immediate favor in lighter-than-the-air circles is evident. As soon as experts of the Akron Company had reached their decision, a similar contract was placed with the A. O. Smith Corp. by the Bureau of Aeronautics of the U. S. Navy Department. This calls for some fifty tanks of substantially the same dimensions to be installed at the Lakehurst field, and adds 320,000 cu. ft. of dischargeable gas to their facilities in anticipation of the giant zeppelins contracted for.—*News Ed., Ind. & Eng. Chem.*

CONCERNING THE FUTURE OF THE ONE-YEAR CHEMISTRY COURSE*

O. F. STAFFORD, UNIVERSITY OF OREGON, EUGENE, OREGON

A writer in one of the early issues of THIS JOURNAL[1] makes the statement that about five hundred papers dealing, substantially, with the question of why we teach chemistry had been printed up to that date. It is safe to say that since then as many more have appeared. The present writer has not had the time to review this thousand or more contributions for their exact content, but from a fairly thorough familiarity with such articles feels that most of them are essentially a defense of the subject of chemistry as it now exists in the school curriculum. That such defensive measures should be taken is itself emphatic evidence that the course is under attack. This attack, when investigated, proves to be a great deal more than a mere repercussion of the fulminations directed against the study of science in the schools by the classicists of the last century as they resisted encroachments of science upon their curriculum. It carries, indeed, a much more serious implication which amounts to the accusation that the results obtained in the one-year chemistry course are quite incommensurate with the time, energy, and resources devoted to it. The attack has been met as well as may be in the aforesaid defensive articles, mainly by asserting, time and again, the benefits that *ought to* accrue from the course, these benefits being predicated almost exclusively upon a theory of education known as the doctrine of formal discipline.

Now while the present writer does not pretend to be versed in the niceties of educational psychology, having merely struggled along for upward of a third of a century in the effort to get over to his students, through main strength and awkwardness, such knowledge of chemistry as might be possible by such means, it nevertheless does seem that the doctrine of formal discipline is pretty thoroughly discredited. If this is true, then the scores and hundreds of adroitly worded objectives which have been set forth as reasons why every one should take a year course in chemistry must for the greater part be discarded as fantastic, aspirational, or even emotionally aspirational. Such a caustic pronouncement as this would not be justifiable, of course, were it based merely upon the collapse of a time-honored educational point of view. But when it is supported, as it is, by a growing conviction among the friends of chemistry that all is not well with the one-year course, when searching analyses into the situation by these same friends of chemistry have disclosed things which are amazingly disconcerting, to say the least, it then becomes almost necessary to admit that the critics are measurably right. It is clearly to be understood here, of course, that the criticism is not applicable to chemistry courses which concern

* Presented before the Division of Chemical Education of the A. C. S. at Minneapolis, Minnesota, September 12, 1929.

[1] Earl R. Glenn, **2**, 670 (Aug., 1925).

the making of the professional chemist or the training of one who for any reason seeks a command of chemistry as an avocation or as a working tool. Such persons, however, constitute a group which must follow the study of chemistry for at least four years, and in numbers are only a per cent or two of all who now enter the one-year chemistry course.

It was largely in response to the obvious necessity of bettering the situation that the Division of Chemical Education was instituted some years ago by the American Chemical Society. The growth of interest in the Division has in itself been striking proof that the issue is alive and important. Much has been accomplished as a result of this interest, and unstinted praise is due the men who are responsible. In attempting to locate and characterize tangible results, however, it now appears that effort has been directed almost entirely to the matter of improving the one-year course as it has existed from the beginning. In the opinion of the writer the highly important question of why it is that the one-year course has not worked out in meeting the needs of the hundreds of thousands of students who take only that course has not been adequately discussed, although it certainly has been raised with overpowering emphasis by the few workers who have undertaken to determine objectively what it is that students do get out of it. Would it be sacrilege, then, to contend that what the course needs is not salvaging or renovating, but rather, in the light of our present knowledge, that it be ruthlessly scrapped? It is not pleasant ever to play the rôle of devil's advocate, but in order to raise the above issue definitely it is the purpose of the present paper to advance certain considerations, briefly, and therefore perhaps very inadequately, which may stand in support of the argument that the difficulties in the present one-year course in chemistry are due to faults which can be remedied only by wrecking away the present structure and putting something different into its place.

The first of these considerations is certainly one which must be accepted as a statement of bald truth, namely, that the course in all essential respects is the same thing in both college and secondary school. Disregarding for the moment what the course is and how it got that way, every one knows that secondary school teachers obtain their training in the college course and then proceed to pass it out to their students in the identical form in which they received it, aided and abetted by the fact that a college man wrote the secondary school textbook. It is a fact, indeed, that the more ambitious high-school teacher, just to show that he is thoroughly competent, outdoes the college teacher in making the course highly technical. This tendency, incidentally, frequently has the unfortunate result that the college teacher, feeling the necessity of presenting something more advanced than his students got in high school, moves his subject matter up a degree or two as to difficulty, the result eventually re-

turning to the high school and thereby creating a vicious spiral. However all this may be, the fact indisputably remains that the one-year course is much the same thing wherever it may be found, and that its form and character are determined by the college course.

This fact, then, leads immediately to a second consideration which is that the college course is and always has been nothing other than the introduction to a four-year program of chemistry study. As such it may be conceded that it meets the needs of the student who may validate his efforts in the first year by necessary further study, but it does not follow at all that it yields adequate values to the student who does not carry through. The situation here, indeed, appears to be quite parallel to that of the student who goes through a single-year course of foreign language study: the effort so expended gives values, as every one knows, only if through years of subsequent study the ability to use the language is acquired. It is not necessary, however, to have recourse to parallelisms or analogies to substantiate the suspicion that values may fail to inhere without further study and lots of it, if any credence can be given whatsoever to the results which have been obtained in recent years from sincere and unbiased efforts to find out just what it is that students do carry away from the one-year course. It certainly is a bitterly discouraging thing to the teacher that after the lapse of even a year the retention of subject matter as well as of other discernible values seems to be vanishingly small. Does not all of the evidence, then, lead inevitably to the conclusion that we are now attempting something impossible?

The subject matter of chemistry has to do, generally speaking, with certain selected phenomena in the environment as well as with their interpretation in terms of the members of a conceptual structure which we call theory. The phenomena in question are closely related to every aspect of existence, and no one questions the desirability of having every man possess such a familiarity of both the phenomena and their interrelationships that he could readily capitalize them in making his personal environmental adjustments. That this might eventually be the goal in scientific education was a hope, and perhaps even an expectation of the early fathers. As time has gone on, however, the complexity of phenomena has shown itself to be stupendously greater than the men of seventy or more years ago ever dreamed it could be. The hard, massy, atom of Newton, and likewise the atom of Dalton fuzzily enveloped in caloric, became, as Rowland in the eighties said, as complicated as a grand piano, and only yesterday as tenuous as the nature of thought itself. Theory has had to keep abreast of this almost incomprehensible opening out of the phenomenal world until today it is the task of a lifetime to obtain a sufficient command of some limited aspect of it to make it effective as a tool. It is a disappointment, certainly, that things have become less simple, less easy to grasp

in a comprehensive way. The chemistry of everyday life instead of becoming understandable to every one, tends more and more to become the despair even of the specialist. Many things that to Mrs. Marcet were quite clear are all but unfathomable today. We are quite obviously in a situation where the more we know the less we know that we know. And yet, in the face of all of this, are we not guilty of adhering solemnly to a century-old ideal in educational practice which is as unfitted to conditions today as an ox-team upon Fifth Avenue, declaring that we teach the common man a smattering of chemical theory in the course of a few weeks so that it will be a matter of practical use to him?

It may be argued at this point, to be sure, that much more than mere theory is imparted to the student in the one-year course. Figures have been compiled showing the relative proportions of informational matter and of theory that are comprised in the conventional presentation of the course, and informational matter does seem to preponderate. In spite of this statistical evidence, however, most teachers of chemistry probably admit that it is the attempt to teach and to apply a bit of theory that consumes the energy allotted to the course. Granting, however, that much information is involved, and there certainly is a lot of it, of what value is it to the man who is not going to be a chemist? The time was, not so long ago, when much was made of the old adage that knowledge is power. The more nearly a man might succeed in those days in making a walking encyclopedia of himself, the more effective he was supposed to be. The point of view has changed radically, however, and is aptly characterized by A. N. Whitehead in his recently published book of essays[2] when he asserts that the most useless bore upon God's earth is the merely well-informed man, that the acquisition of inert ideas is the most serious obstacle to be encountered in the educational process. Robinson, in his tract entitled "The Humanizing of Knowledge" likewise points out the absolute necessity of transmuting knowledge into wisdom if it is to be effective in rounded living. That there are occasional facts inside the covers of the general chemistry textbook that can be transmuted into wisdom by the student as he labors with them and that there are some ideas there which cannot be regarded as inert is not to be denied. But when one considers the simply enormous amount of time and energy devoted to learning the meanings of hundreds of technical terms such as deliquescence, dispersoid, dialysis, and the like: and of acquiring the ability to write equations for the reaction between sulfur and sodium hydroxide, the reaction for making chlorine, and so on with a thousand others, what boots it, anyway? Are not these ideas, both at the time and ever afterward, completely in the class of inerts in so far as the layman is concerned? If Whitehead is at all correct, are we not rendering such a student an egregious

[2] "The Aims of Education," A. N. Whitehead, Macmillan Co., New York, 1929.

disservice in insisting that he learn these things? Have not Slosson, Gregory, Howe, the editors of the popular magazines, and for that matter the editors of the more serious magazines, too, all learned the better way of imparting the informational matter that the layman should know and apply in so far as application is possible? Is it not true that the news story writer, with his extraordinarily developed sense of what will make an appeal is far ahead of the textbook writer in his selections and presentations of informational matter? Do not the news-reel editor and the radio station manager likewise far out-distance the textbook authors in these respects?

There remains for final arraignment in this discussion certain claims, often made, that the experiences encountered in the one-year course are particularly potent in the development of desirable character traits, in the gaining of appreciations, and the like. It is unfortunate for those who argue either for or against the validity of these claims that their cases cannot be proved satisfactorily for the obvious reason that the qualities in question are not of a kind that can be subjected to quantitative measurement. To be consistent in his present rôle of devil's advocate the writer is compelled to take the point of view that there is very little in the course that does contribute either to the development of character or to the gaining of appreciations. To enumerate all of the reasons would take vastly more time than is here available. Some of the supporting evidence would be a reiteration of things that have been adduced in preceding paragraphs. But can you distinguish a student who has had the one-year course from one who has not had it by any conceivable test involving personal qualities, altruistic tendencies, breadth of view, or what else you will? Granting that the opportunity is offered in laboratory work and elsewhere of facing the stern and unyielding rules of the great game which Nature plays, is it not true that more men are broken under crucial tests involving character than survive the tests? In cases, for instance, where an apparent conflict exists between what Nature seems "to say" in the laboratory and what the instructor is supposed "to want," how often does it happen that the student reports the saying instead of the wanting? The answer to this question, however it may be given, will depend not upon any ennobling or rectifying influence exerted by the subject matter, but almost wholly upon the teacher and his relationship to the student. In spite of claims to the contrary the practice of ascribing miracle-working powers to short-time exposures to curricular subject matter, whatever it is, is a fatuity in a class with pinning prayers to a prayer wheel. The faults and futilities that attach to the one-year course in chemistry, it is only fair to say, can with equal force be urged against the other one-year science courses and in addition against certain mathematics courses.

As to what the solution shall be the writer can in the time that is avail-

able do little more than point out possibilities. These are neither new nor original, since they are in the air, so to speak, where they are slowly but surely taking form. In the first place full recognition must be given to the fact that highly technical aspects of theory in science are sharp tools, requiring years to fashion, necessary for the specialist and useless to the non-specialist. For the ordinary mortal they are like the express train chased by a dog. Express trains are exceedingly useful things when in their proper place, but it would be an extraordinary dog kennel that would house one, and of what use would it be there? To attempt to give a workable knowledge of theory in a year is an impossibility and experience shows that the few things which are imparted to the student belong thereafter to the category of inert ideas. One-year courses attempting to impart the ultimates of theory are the withered outcomes of well-intentioned hopes held by the educators of seventy years ago. There is apparently but one thing to do with them and that is to abrogate them, except in the colleges where they should be made to perform more rigorously than ever their present function of starting the student upon a program of study to be continued for years or a lifetime.

In setting up something to take the place of one-year science courses it is to be remembered first and always that Nature is one big thing and that it is both desirable and possible for every educated man to understand its larger aspects even though its ultimate aspects have become incomprehensibly complex and impossibly multitudinous. It was this knowledge of proximate Nature that the early fathers really aspired to, and those aspirations are as valid today as they ever were. That we should forsake the pursuit of ultimates in general education and get back to the proximates is an obvious duty. The need for doing this has been sensed for a long time and found expression more than a decade ago in the general science movement. This movement has not been as respectable as it should be for various reasons that cannot be cited here. At the present moment, however, there is an insistent demand in the colleges for what are called survey or orientation courses in science. This demand is based openly upon the felt need of proximate understandings of Nature as a whole. In the opinion of the writer these courses are doomed to failure for the simple reason that in them also altogether too much is attempted for the time that is available. To obtain the values aspired to is the task of four years or six years rather than of one. It is a task that should be commenced in the grades and should continue through all of the secondary school years as a unified, coherent, progressive program. This is the thing that should be substituted for all of the present one-year courses.

You say that we cannot accomplish the impossible; but all history is the impossible, the unforeseen, forged into reality by the brain and the muscles of man.—MUSSOLINI

SHOULD LABORATORY OR RECITATION HAVE PRECEDENCE IN THE TEACHING OF HIGH-SCHOOL CHEMISTRY?*

ROSALIE M. PARR AND MABLE A. SPENCER, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS

At the Swampscott meeting of the American Chemical Society, Professor Frank M. Greenlaw[1] gave the summary of results obtained from a questionnaire sent to high-school chemistry teachers on the question of the superiority of method in teaching when precedence was given to the laboratory, or when given to the recitation. Professor Greenlaw found that the answers to the questionnaire left the conclusion in doubt, and he expressed the opinion that the problem should be worked out in the classroom.

The research committee of the Illinois Association of Chemistry Teachers undertook the testing of this problem through a coöperative plan. Through the medium of letters, and through the presentation of the problem at the fall meeting of the association, twenty-two teachers were enlisted in the research. These teachers were in charge of thirty-five classes composed of 857 high-school chemistry pupils.

Objectives

Two distinct purposes were in mind at the inception of this problem: (1) to give to the chemistry teachers of Illinois an opportunity to coöperate on an educational problem; (2) to determine, if possible, whether the precedence of laboratory or of recitation produces the best results under ordinary teaching conditions in high-school chemistry classes.

The aim was to test in a quantitative way a simple factor which may be expressed in the questions: Is there an advantage to the pupil who endeavors by his own efforts in laboratory to determine a fact, observe a phenomenon, or solve a problem, before he has other understanding of it than material given in a page of directions and references; or does the advantage come to the pupil who has an understanding of the phenomenon through demonstration and discussion by the teacher and who then performs the laboratory experiment in order to make the whole thing real to him through confirmation and review of this material? Does the effort to solve the given problem, which frequently remains hazy in his mind to the end of the exercise, have a measurably beneficial effect more than does the effort in the laboratory which is made easy for him through previous classroom discussion? Does the very hardness of the problem and difficulty of situations make the learning of more value, and will his mind become more deeply saturated with the facts and abilities used, thus making retentions more firmly fixed and the material learned more usable in new situations? Will there be measurable differences in pupils trained by the two methods in regard

* Read before the Division of Chemical Education, at the 78th Meeting of the American Chemical Society, Minneapolis, Minnesota, September 12, 1929.

[1] *Committee Report*, THIS JOURNAL, **5**, 1300 (Oct., 1928).

to retention (1) of things observed, (2) of the reasoning processes called into play, (3) of the association made with the book illustrations and descriptions, and (4) of transfer in reasoning ability? Will "immediate" recall tests of the given material show one method or the other superior? Will "delayed recall tests" show measurable differences in the retention of the different kinds of learning? Will one of these methods show superiority for the students of the upper quartile and possibly prove inferior for the students of the lower quartile? Will small schools show a difference in the median of learning as compared with larger schools? Will a teacher's preference for one method or the other have weight in the results obtained?

Plan of Procedure

A study of the calcium family was selected as the unit upon which to base the testing of the two methods of presentation. This unit contains concise material that generally requires two weeks of the time allotted to second semester high-school chemistry classes, and thus seemed well suited to the purpose of this research. The accompanying laboratory work contains problems of a nature that appeals to pupils and that are of a range of difficulty within their ability. There is much to observe; there are definite principles to be applied; and there are excellent opportunities for problem solving.

The textbooks used by the chemistry classes that were to be placed under experimental conditions were ascertained, and the material to be covered was designated by page numbers in each of these texts under the heading of "References" at the beginning of each experiment. The directions for experiments were selected from standard laboratory manuals and a mimeographed copy was provided for each pupil. Laboratory instructions were carefully prepared in detail so that the teachers could not vary the experiments.

The same unit and identical experiments were studied by the classes under the two experimental methods. An exception to this was made for the smallest schools where only one class in chemistry was available the second semester. In these schools the same pupils were taught the calcium family by one method and the magnesium-zinc group by the other method. The latter unit was carefully prepared to balance the calcium unit. By this plan the smaller schools were able to take part in the complete research, and although a slight deviation in results may have been introduced by a second unit, this was practically negligible because of the relatively few pupils concerned.

A guide sheet for the teachers included the following essential directions:

At the beginning of the class period preceding the beginning of the experiment, a text assignment is made and direction sheets given to students in both classes without comment further than that this is the next day's assignment.

At the next meeting of Class A the teacher *presents* and *discusses the topic before any laboratory work is done by students.* The teacher makes any demonstration desired and discusses the experiment in detail. A general recitation on content is conducted before the pupils do any laboratory work. The pupils are then directed to do the laboratory assignment, which amounts to a confirmation and review of material already discussed. The experiment should be neatly written into the notebook and all questions answered.

All of the work outlined for this experiment should be given to *Class A* by this method, using as many hours of recitation as seem necessary. All experiments should be completed in full by pupils and results recorded.

At the first meeting of *Class B* the students are directed to follow the directions for laboratory experiments, to read the assignments in the text and supplementary reading, and *find out for themselves* the things called for in the outline. A definite assignment should be made for each day's work, but please note that the content must not be discussed by the teacher before the readings and the laboratory assignments are completed by the pupils. The teacher, however, may answer questions and suggest pages in reference books where help may be found. The pupils should make neat records in notebooks of the work accomplished and answer all questions. After the laboratory work is completed the teacher will now give the same demonstration (if any), discuss the experiments, and have the same general recitation on content, that had been given in *Class A* at the beginning. The teacher should have the class recitation in the two classes, *A* and *B*, as nearly as possible identical.

An outline of the calcium unit was prepared and a copy was sent to each of the coöperating teachers. This outline follows:

OUTLINE OF THE CALCIUM UNIT

(Approximate time two weeks)

METALLIC CALCIUM

1. *Preparation*—electrolysis of a fused calcium salt.
2. *Properties.*
   - *A. Physical*—silver white metal; brilliant luster; about same hardness as lead.
   - *B. Chemical*—combines with water, liberating H_2; combines O_2 of air to form CaO.
3. *Use*—Preparation of H_2 in laboratories.

CALCIUM CARBONATE

1. *Occurrence*—common names: limestone, chalk, marble, air-slaked lime, whiting. In combination with Mg, dolomite.
2. *Methods of preparation*—lime water and carbon dioxide [excess CO_2 will form $Ca(HCO_3)_2$]. Air slaking of lime. Compare solubilities.
3. *Physical Properties*—color, flame test, solubility, forms.
4. *Hard water*—definition of temporary and permanent; methods of softening, including Permutite; problems.
5. *Uses*—chalk, polishing powder; whiting mixed with 15–18% linseed oil is putty; limestone in blast furnaces; limestone for building.
6. *Boiler scale*—disadvantages of hard water in boilers—poor conductor of heat, clogs pipes.
7. *Limestone deposits*—occurrence in Mark Twain Cave, Mammoth Cave, Luray Cavern. Stalactites, stalagmites.

QUICK LIME OR CALCIUM OXIDE

1. *Preparation*—Rotary lime kiln.
2. *Properties.*
   A. Physical—color; solubility; fuses and vaporizes at 3500°F.; lime light.
   B. Chemical—combines with water to form $Ca(OH)_2$; slaked lime.
3. *Uses*—limewater in medicine; mortar.

SLAKED LIME OR CALCIUM HYDROXIDE

1. *Preparation*—water and calcium oxide; lime and moisture from the air.
2. *Properties.*
   A. Physical—white solid; suspended solution (milk of lime); sparingly soluble in water.
   B. Chemical—basic in reaction; neutralizes acids to form Ca salts.
3. *Uses*—manufacture of alkalies; making of glass; whitewash; removal of hair from hides; water softening; preparation of mortar; bleaching powder; milk of lime.

MORTAR

1. *Preparation*—slaked lime, sand, and hair.
2. *Properties*—soft mass which hardens when exposed to air; loses water; absorbs CO_2 forming $CaCO_3$.
3. *Use*—building.

CEMENT

1. *Preparation*—composition of concrete; reinforced concrete.
2. *Uses*—bridges, buildings, walks.

PLASTER OF PARIS

1. *Preparation*—heat gypsum to 175°C.

CALCIUM PHOSPHATE

1. *Occurrence*—bones of animals; guano, a phosphate deposit in Chile.
2. *Properties*—normal phosphate; superphosphate of lime.
3. *Uses*—animal and plant food; fertilizers; baking powders; calcium salts in diet; foods rich in calcium.

CALCIUM CHLORIDE

1. *Preparation*—calcium hydroxide and hydrochloric acid.
2. *Properties*—color, white. Deliquescent.
3. *Use*—drying agent.
4. *Bleaching powder*—preparation and properties.

CALCIUM CARBIDE

1. *Preparation.*
2. *Properties.*
3. *Uses*—preparation of acetylene, carborundum.

BARIUM AND STRONTIUM

1. Similarity of members in family.
2. $BaCl_2$ test for sulfates.
3. Flame tests.

Tests

Two tests of twenty questions each of immediate recall were prepared from the subject matter covered in the unit of work. Special effort was made to have these tests well balanced. Any lack of balance was compensated by distributing each test equally among the *A* and *B* experimental groups. Two weeks after the study and direction sheets were sent to the teachers, the immediate recall tests followed. They were given by the teachers and returned to the writers for grading.

IMMEDIATE RECALL TEST ON CALCIUM FAMILY—SET IA

1. What calcium salt gives off bubbles when treated with HCl?
   Of what were these bubbles composed?
2. What salt of calcium was formed in (1)?
   What happened to this salt when evaporated to dryness and allowed to stand in the air?
3. How did you detect the presence of Na_2CO_3 in a sample of washing powder?
4. What change did you observe in the colored calico when placed in an acidified solution of $CaOCl_2$? Account for this change.
5. A salt tested on a platinum wire gave a green color to the flame. Which had been used—a calcium, barium, or strontium salt?
6. To prevent oxidation, under which conditions should metallic calcium be kept?
7. How many grams of CaO would be required to prepare 200 grams of $CaCO_3$?
   Ca—40. O—16. C—12.
8. Write the equation for the preparation of $Ca(OH)_2$ from CaO.
9. Complete and balance the following: (1) Na_2CO_3 and $CaCl_2$; (2) $CaCO_3$ and heat; (3) $NaNO_3$ and $Ca(OH)_2$.
10. Give number of the preceding reactions (9) which go to completion and state reasons for going to completion.
11. Give the symbol of calcium. Valence.
12. Write the formulas of 4 common calcium compounds found in nature.
    (1) (2) (3) (4)
13. What calcium compound may be used at the present time as a source of calcium metal? What operation is performed on it to obtain the calcium metal?
14. What is a stalactite? Where found?
15. Name 4 of the important uses of $CaCO_3$.
    (1) (2) (3) (4)
16. What is whiting? For what used?
17. A mixture of CaO, water, sand, and hair is called.....?
18. Give formula for calcium carbide.
    Two uses for calcium carbide. (1) (2)
19. Write the formulas for (*a*) barium nitrate, (*b*) strontium oxide, (*c*) barium chloride.
20. Write the equation to show what would be formed if $Sr(OH)_2$ were treated with CO_2.

Six weeks later two delayed recall tests of twenty questions each, prepared to cover the same unit of work but repeating none of the questions of the first test, were likewise distributed to the teachers and the completed tests returned to the writers as before.

DELAYED RECALL TEST ON CALCIUM FAMILY—SET IIB

1. What gas bubbled through lime water turned it milky?
   Give formulas for the products formed.
2. What happened when an excess of the gas mentioned in No. 1 was bubbled through the milky solution?
3. What method did you use to distinguish between Na_2CO_3 and borax?
4. What did you observe when you boiled tap water? Name one compound which probably was present.
5. A salt tested on platinum wire gave a brick-red color to the flame. Which was present: a salt of Ca, Ba, or Sr?
6. What per cent of CaC_2 is carbon? Ca = 40. C = 12.
7. How many grams of $CaCO_3$ could be formed from 37 grams of $Ca(OH)_2$?
   Ca = 40. C = 12. H = 1. O = 16.
8. $BaCl_2$ was added to (1) $CaCl_2$. (2) Na_2CO_3. (3) K_2SO_4. (4) HNO_3.
   Underline the compounds with which insoluble compounds would be formed.
9. Which of the reactions in No. 8 would go to completion? Reasons for answer.
10. Calcium salts are necessary for the formation of what parts of the body?
11. What is the composition of ordinary chalk?
12. Of what is stalagmite composed? Where found?
13. Sketch the apparatus used in preparing CO_2 from limestone.
14. Write the formula for the substance that is used to revive the water softener in the Permutite method.
15. What is reinforced concrete?
16. What is the composition of mortar?
17. Write formulas for (*a*) calcium acid carbonate, (*b*) air-slaked lime, (*c*) calcium phosphate, (*d*) strontium nitrate.
18. Name a calcium compound which contains water of crystallization.
    How is it used?
19. State 2 uses of bleaching powder. (1) (2)
20. If you were given a sample of SrO, how would you prepare $SrCO_3$?

In all of these tests an effort was made to discern variations in the kind of learning retained by the two methods. Five questions in each test included "observations" made in the laboratory; five were designed to test "reasoning;" eight could be answered from textbook knowledge alone, and were called "memory" questions. Two were designed to test a possible "transfer of reasoning," the answers being derived by a one-step reasoning process if the assigned work was understood.

Scoring was done on the percentage basis. A perfect paper received a score of twenty-five per cent on five "observation" questions, twenty-five per cent on five "reasoning" questions, forty per cent on eight "memory" questions, and ten per cent on two "transfer of reasoning" questions. The score for each question having a perfect answer was five per cent; thus, the sum of all the weighted scores on one paper gave a total on the percentage basis for the complete paper. Any difference in total value of the two sets of questions used was eliminated in the grand total of scores by having the two sets of questions distributed equally to the classes under the two methods.

Since the success or failure in the year's work of individual pupils in the course was in no way dependent on the scores given, the grading was severe and impartial. The lowest and highest scores were 6 and 100, respectively, one pupil making each of these grades, while practically all numbers between 6 and 100 were represented in the range of scores.

Calculations and Results

The scholastic average for each pupil during his attendance at high school was secured from the schools. These measured achievement and, indirectly, pupil intelligence. They served as a basis for correlation and for pairing students. Calculation of correlation of the scores earned in the immediate recall test with the scholastic averages showed the test to have a coefficient of correlation of 0.523 and that of the delayed recall test with the immediate recall test was 0.757.

Contrary to the findings of Miller,[2] who found a very low correlation in grades given by a small group of physics teachers with his objective test grades, we found the correlation of the scholastic averages of this

TABLE I

MEAN VALUES FOUND IN THE SCORES AND IN THE CORRESPONDING PER CENTS FOR IMMEDIATE AND FOR DELAYED RECALL TESTS BY THE "RECITATION FIRST" AND THE "LABORATORY FIRST" METHODS FOR THE TOTAL NUMBER OF STUDENTS TESTED. THE ASTERISKS INDICATE THAT THE PERCENTAGE DIFFERENCE IS IN FAVOR OF THE "RECITATION FIRST" METHOD

Maximum scores			25	25	40	10	100
Method	No. of pupils	Scholastic average	Observation	Reasoning	Memory	Transfer reasoning	Mean calc. of scores
MEAN OF IMMEDIATE TEST SCORES							
A							
Rec. First	417	81.3	18.2 (72.8)	17.9 (71.6)	27.5 (68.8)	7.9 (79.0)	71.5
B							
Lab. First	440	83.8	17.7 (70.8)	17.2 (68.8)	27.2 (68.0)	7.4 (74.0)	69.6
Percentage difference			(2.0*)	(2.8*)	(0.8*)	(5.0*)	1.9*
DELAYED TEST SCORES							
A							
Rec. First	356	83.3	15.1 (60.0)	15.2 (60.8)	23.2 (58.0)	6.7 (67.0)	60.2
B							
Lab. First	305	83.9	14.1 (56.4)	13.0 (52.0)	21.5 (53.8)	6.4 (64.0)	55.0
Percentage difference			(3.6*)	(8.6*)	(5.2*)	(3.0*)	5.2*

[2] Miller, Paul S., "A Quantitative Investigation of Efficiency of Instruction in High-School Physics," *J. Educ. Res.*, **5**, 119–27 (1929).

group of approximately seven hundred pupils with the immediate test grades to be substantial, showing that teachers' marks in these high schools are fairly correct, and that the tests used in this research were reasonable.

After the scoring of the papers was completed, all the individual scores were recorded. From these data calculations were made to determine the mean values for the total population taught under each of the two experimental methods, as shown in Table I. In this table the maximum scores for each kind of learning is shown at the head of the columns. The scoring was at first made upon this basis and the sum of the average scores for "observation," "reasoning," "memory," and "transfer reasoning"

TABLE II

A COMPARISON OF SCORES, AND THEIR PERCENTAGE VALUES IN PARENTHESES, MADE BY PAIRED SETS OF PUPILS IN THE UPPER AND THE LOWER QUARTILES IN THE IMMEDIATE, AND IN THE DELAYED, RECALL TESTS FOLLOWING THE "RECITATION FIRST" AND THE "LABORATORY FIRST" METHODS. THE ASTERISK INDICATES DIFFERENCE IN FAVOR OF "RECITATION FIRST" METHOD

Maximum scores / Method	No. of pupils	Scholastic average	25 Observation	25 Reasoning	40 Memory	10 Transfer reasoning	100 Mean calc. of scores
UPPER QUARTILE							
IMMEDIATE RECALL TEST							
Rec. First	73	92.7	19.5	20.8	29.9	8.7	78.9
			(78.0)	(83.2)	(74.8)	(87.0)	
Lab. First	73	92.7	20.8	20.4	32.3	8.8	82.3
			(83.2)	(81.6)	(80.8)	(88.0)	
Percentage difference			(5.2)	(1.6*)	(6.0)	(1.0)	3.4
DELAYED RECALL TEST							
Rec. First	59	92.7	17.0	17.5	25.8	7.4	67.7
			(68.0)	(70.0)	(64.5)	(74.0)	
Lab. First	59	92.6	16.7	15.8	24.7	7.9	65.4
			(64.8)	(63.2)	(61.8)	(79.0)	
Percentage difference			(3.2*)	(6.8*)	(2.7*)	(5.0)	2.3*
LOWER QUARTILE							
IMMEDIATE RECALL TEST							
Rec. First	68	74.9	16.5	14.4	24.7	7.4	63.0
			(66.0)	(57.6)	(61.8)	(74.0)	
Lab. First	68	74.7	15.6	15.4	23.4	6.8	61.2
			(62.4)	(61.6)	(58.5)	(68.0)	
Percentage difference			(3.6*)	(4.0)	(3.3*)	(6.0*)	1.8*
DELAYED RECALL TEST							
Rec. First	56	75.2	13.0	11.3	20.5	5.3	50
			(52.0)	(45.2)	(51.3)	(53.0)	
Lab. First	56	75.0	12.9	9.1	18.2	5.3	48.5
			(51.6)	(36.4)	(45.5)	(53.0)	
Percentage difference			(0.4*)	(8.8*)	(5.8*)	(0.0)	4.5*

gave the mean score on the basis of 100 for the experimental group. The scores for each kind of learning were then converted into percentage scores for each type, which are shown in parentheses. The differences of the percentage scores were found and the differences favoring the "recitation first" method are shown by asterisks.

The pupils under the two methods were then paired according to scholastic averages, and the upper and lower quartile points determined for each

TABLE III

A COMPARISON OF RETENTION IN SOME DIFFERENT TYPES OF LEARNING AS SHOWN IN THE IMMEDIATE AND DELAYED RECALL TESTS EXPRESSED IN PERCENTAGE SCORES, FOR THE TOTAL NUMBER OF PUPILS, AND FOR THE PAIRED SETS OF PUPILS IN THE UPPER AND LOWER QUARTILES. THE ASTERISKS SHOW WHERE DIFFERENCES ARE IN FAVOR OF "RECITATION FIRST" METHOD

"RECITATION FIRST" SCORES

	Kinds of tests	No. of pupils	Scholastic average	Observation	Reasoning	Memory	Transfer reasoning
All	Immediate	417	81.3	72.8	71.6	68.8	79.0
population	Delayed	356	83.3	60.0	60.8	58.0	67.0
tested	Loss			12.8	10.8	10.8	12.0
Upper	Immediate	73	92.7	78.0	83.2	74.8	87.0
quartile	Delayed	59	92.7	68.0	70.0	64.5	74.0
	Loss			10.0	13.2	10.3	13.0
Lower	Immediate	68	74.9	66.0	57.6	61.8	74.0
quartile	Delayed	56	75.2	52.0	45.2	51.3	53.0
	Loss			14.0	12.4	10.5	21.0

"LABORATORY FIRST" SCORES

All	Immediate	440	83.8	70.8	68.8	68.0	74.0
population	Delayed	305	83.9	56.4	52.0	53.8	64.0
tested	Loss			14.4	16.8	14.2	10.0
Upper	Immediate	73	92.7	83.2	83.4	80.8	88.0
quartile	Delayed	59	92.6	64.8	63.2	61.8	79.0
	Loss			18.4	20.2	19.0	9.0
Lower	Immediate	68	74.7	62.4	61.6	58.5	68.0
quartile	Delayed	56	75.0	51.6	36.4	45.5	53.0
	Loss			10.8	25.2	13.0	15.0

SUMMARY

Loss for	Recitation First	12.8	10.8	10.8	12.0
total	Laboratory First	14.4	16.8	14.2	10.0
Population	Difference	1.6*	6.0*	3.4*	2.0
Loss for	Recitation First	10.0	13.2	10.3	13.0
upper	Laboratory First	18.4	20.2	19.0	9.0
quartile	Difference	8.4*	7.0*	8.7*	4.0
Loss for	Recitation First	14.0	12.4	10.5	21.0
lower	Laboratory First	10.8	25.2	13.0	15.0
quartile	Difference	3.2	12.8*	2.5*	6.0

group. The comparison of mean scores made by the pupils under the two methods is shown in Table II.

The difference in the scores made by each group in the immediate and delayed tests, which we may designate as "loss of learning," is shown in Table III, which also includes a summary that gives a comparison of "loss of learning" under the two experimental methods.

That teachers' preferences of methods may have influenced the scores made by pupils was tested by placing in two groups those teachers who

TABLE IV

INFLUENCE OF TEACHERS' PREFERENCE ON THE MEAN PERCENTAGE SCORES MADE BY PUPILS IN THE IMMEDIATE AND DELAYED TESTS FOLLOWING THE "RECITATION FIRST" AND THE "LABORATORY FIRST" METHODS OF TEACHING. THE ASTERISKS INDICATE DIFFERENCES IN FAVOR OF "RECITATION FIRST" METHOD

IMMEDIATE TEST SCORES

Teachers' preference	Method	No. of pupils	Scholastic average	Observation	Reasoning	Memory	Transfer reasoning	Mean calcd. on scores
Rec. First	Rec. 1st	131	84.8	82.8	80.0	70.8	72.0	75.0
Preferred	Lab. 1st	140	82.4	72.4	58.8	64.0	76.0	59.3
	Difference			10.4*	21.2*	6.8*	4.0	15.7*
Lab. First	Rec. 1st	180	85.4	68.8	65.4	64.0	80.0	67.2
Preferred	Lab. 1st	178	85.2	75.6	72.2	67.7	79.0	72.2
	Difference			6.8	9.8	3.7	1.0*	5.0
No preference	Rec. 1st	80	82.7	69.6	62.0	67.3	81.0	67.0
of method	Lab. 1st	89	83.0	62.4	67.2	70.5	67.0	67.2
	Difference			7.2*	5.2	3.2	14.0*	0.2

DELAYED TEST SCORES

Rec. First	Rec. 1st	95	85.6	67.6	64.0	64.3	69.0	65.6
Preferred	Lab. 1st	80	83.7	50.8	59.2	55.0	68.0	56.4
	Difference			16.8*	4.8*	9.3*	1.0*	9.2*
Lab. First	Rec. 1st	172	82.5	59.2	56.8	57.0	64.0	58.6
Preferred	Lab. 1st	154	84.5	58.8	53.6	53.8	62.0	55.6
	Difference			0.4*	3.2*	3.2*	3.2*	3.0*
No preference	Rec. 1st	89	83.0	59.6	64.8	53.3	69.0	57.8
of method	Lab. 1st	71	82.8	57.2	40.4	52.8	65.0	52.0
	Difference			2.4*	24.4*	0.5*	4.0*	5.8*

early in the work had expressed the preference for either of the two experimental methods, and by placing in a third group those who had stated no preference. Mean scores were calculated and the results are shown in Table IV.

A suggestion that the size of the school may in some way be reflected in the total scores made by pupils led to listing the coöperating schools in four groups according to their respective registrations. Mean scores were calculated and these are shown in Table V.

TABLE V

A COMPARISON OF THE GROUP SCORES OF PUPILS IN THE IMMEDIATE AND DELAYED RECALL TESTS ACCORDING TO THE SIZE OF SCHOOL

			First Test	Final Test	
Group no.	School population	Number of pupils	Mean immediate test scores	Number of pupils	Mean delayed test scores
I	Less than 200	63	72.7	63	69.5
II	200–400	172	65.5	98	53.7
III	400–800	330	72.6	266	57.1
IV	800–2300	189	72.0	192	56.8

Inspection of the immediate test scores for the total population under experimental conditions in Table I shows very little advantage for either of the methods tested but there appears a definite tendency toward the "recitation first" procedure which tendency is emphasized in the results of the delayed test. Although the differences here are too small to be conclusive they indicate that further analysis of the data is desirable. It may be noted that the total number of pupils taught under the two methods shown in Table I are not equal and that the differences in scholastic averages of the two groups in the delayed test is fairly large. Steps were next taken to select and calculate data for groups of nearly equal ability and numbers.

The pupils taught under each of the experimental methods were listed according to their respective scholastic averages. Pairs of students having the same scholastic average were selected. For instance, a pupil in the "recitation first" group having a scholastic average of ninety-seven was paired with a pupil in the "laboratory first" group having the same scholastic average. Pupils having a scholastic average of ninety-six were likewise paired from the two groups, and so on down for all pupils of the upper and of the lower quartiles. For these equated groups, calculations and comparisons of scores were made and the results are given in Table II.

It is of interest to note that in the upper quartile (Table II) the average scores made on the immediate recall tests show superiority in observation and memory by "laboratory first" method, whereas in the lower quartile superiority in observation and memory is shown in the "recitation first" method. The average scores in the delayed recall tests in both the upper and the lower quartiles show a superiority in the "recitation first" method. It is also of interest that although reasoning in the lower quartile is somewhat higher in the "laboratory first" method in the immediate test, it is much higher in the "recitation first" method in the delayed test.

A further analysis of data is made in Table III in which there is shown a difference in mean percentage scores by the two methods which we may designate as "loss of learning." For the total population tested as shown

in the summary of Table III the loss in learning of things observed is practically the same in the two methods, while in reason and in memory the loss is considerably greater in the "laboratory first" method. For the upper quartile the loss of learning is greater in observation, in reasoning, and in memory, in the "laboratory first" method. In the lower quartile the loss of learning is greater in reasoning, and in memory, in the "laboratory first" method. It may be significant that the pupils of the lower quartile retain things learned by observation in the "laboratory first" method somewhat better than in the "recitation first" method.

The questions intended to test the "transfer reasoning" ability are believed by the writers to have been valid for the first test but probably not valid for the second. The questions were based on principles taught in the calcium unit which could be applied to reactions of compounds related to those of calcium. These reactions were normally included in the schedule of the six-weeks interval between the tests, thus invalidating the questions for the purpose intended but not necessarily for the test as a whole.

In Table IV, the influence of a teacher's preference for a definite method is rather sharply portrayed. Seven teachers in charge of experimental groups preferred the "laboratory first" method, seven preferred the "recitation first" method, and six had expressed no preference. It is safe to assume that the pupils had been taught previous to this experiment by the method preferred by the teacher in which case they would be expected to show higher scores by the method under which they had been trained. Although this is not found true for each individual teacher, the total percentage scores show a decided advantage for the method preferred by the group of teachers as shown in the immediate tests. The pupils in classes where the teachers prefer the "recitation first" method show a decided advantage for this method in the immediate test but this advantage is lost in the results of the delayed test. The pupils taught by teachers who have no definite preference show varied results in the immediate test but tend to favor the "recitation first" method in the delayed tests. The results for the immediate tests in Table IV seem to indicate that "whichever method a teacher likes, that method will prove the most successful for him," but inspection of the scores in the delayed test show that retention is higher in all three groups where the "recitation first" method was used. Although we do not doubt that each teacher was able to teach better by his preferred method than by the other, the results of the delayed tests give evidence that the retention of learning was greater under the "recitation first" method of instruction.

Table V shows that the size of school has very little effect upon the scores made by pupils in these tests. The greater retention shown in Group I, representing the small schools, is probably due to the individual

training that is possible in small classes—the number of pupils per class in this group ranging from seven to twenty.

Discussion

The results here recorded seem to corroborate the work of several investigators who have expressed serious doubt of the value of the extensive laboratory program now in vogue in high schools. Anibal,[3] Cooprider,[4] Cunningham,[5] and Kiebler and Woody,[6] in the comparisons of lecture-demonstration and laboratory methods, each found the average percentage scores were higher by the lecture-demonstration than by the laboratory method. Their results differ, however, from those in this investigation in that their average percentage scores for the delayed tests were higher following the laboratory method whereas these data show the average percentage scores on the delayed test are markedly lower where the "laboratory first" method was used.

A research which in object and procedure closely parallels the work here described was conducted by Miss Bagby[7] on three groups of thirty pupils each, the experiment extending through two semesters. She studied three methods of correlating classroom and laboratory work—method 0, no class work before laboratory; method 1, a one-day pre-view in the class before laboratory; and method 2, a completion of the topic in the classroom followed by the experiment. She concluded that (*a*) a change in the relative time of class and experiment has little effect upon pupil achievement; (*b*) telling the results of an experiment before working it out in the laboratory does not appreciably affect what the pupil learns. Our results differ from those of Miss Bagby in that the delayed recall shows a definite advantage for those pupils who were mentally prepared in recitation before attempting to perform an experiment.

Studies at Lakeview High School in Chicago for three years by Herbert Smith[8] give an average of fifty-eight per cent of those enrolled in chemistry classes who were unable to profit by individual work in the laboratory.

Downing[9] states that the benefits supposed to be derived from indi-

[3] Anibal, Fred G., "Investigation of Demonstration versus Laboratory as a Method of Teaching Natural Sciences," *Proc. Nat. Educ. Assoc.*, **26,** 771–2 (1924).

[4] Cooprider, J. L., "Demonstration versus Individual Work in High-School Science," *Sch. Sci. & Math.*, **22,** 838–44 (1922).

[5] Cunningham, H. A., *Ill. H.-S. Conf. Bull.*, **1920.**

[6] Kiebler, E. W., and Woody, Clifford, "The Individual Laboratory versus the Demonstration Methods of Teaching Physics," *J. Educ. Res.*, **8,** 50–8 (1918).

[7] Bagby, Grace, "The Correlation of Laboratory and Classroom Work in Teaching High-School Chemistry," *J. Educ. Res.*, **19,** 336–40 (1929).

[8] Smith, Herbert, "Effectiveness in Laboratory Work in Chemistry," *Sch. Sci. & Math.*, **27,** 267 (1925).

[9] Downing, Eliot R., *Sch. Rev.*, **33,** 688–97 (1925).

vidual laboratory work are found in "the opportunity for the pupil to learn at first hand, to acquire fertility of suggestions, facility in thinking, and self-reliance, by facing problems and solving them for himself." He finds, however, that the pupil fails to realize what the experiments are really for, and that "the scientific experiments as at present conducted are often to be classed as 'busy work' in the high schools—interesting perhaps, but not instructive."

Inquiry into the possible causes of the limited success of the "laboratory first" method leads deeply into child psychology since our high-school pupils are still children, mental maturity not being reached until the true age of eighteen years.[10] Norsworthy and Whitley[11] state that, in general, children lack in richness, in definiteness, and in detail of perception. They tell us that children's perception is largely influenced by the passing mental content. We all tend to see or hear or feel what we expect, and the child is even more influenced than the adult by the passing mental state. Furthermore, "it is very necessary that with a child the aim of the work should be kept very clearly in mind; he should know very definitely what he is to look for or to do if results worth while are to be obtained." The "laboratory first" method, then, fails in this psychological factor that the pupil has not the proper mental set, the aim of the work not being clearly in mind. If this method is to succeed, the teacher in charge should use a technic that will clarify the mental images and aid the fixation of purpose at the beginning of the experiment.

It is well known that the laws of recall are essentially the laws of association. Accurate recall depends both upon the method of learning and the attitude at the moment of recall.[12] Without suggestions from the teacher, associations are meager. It is a question still unanswered whether the richness in background provided by the numerous connections, relations, and uses suggested by the teacher can be compensated for by the initiative that may be developed through leaving the pupil largely to his own resources in the high-school laboratory. In the "recitation first" method the pupil is mentally prepared and he goes into the laboratory with a fixed aim and with a mental state anticipating results.

The "recitation first" method has been used with considerable success ever since classes in chemistry have been taught. The "laboratory first" method belongs to the more recent problem type, having in common with the latter the need in the pupil for individual initiative, a scientific attitude

[10] Otis, Arthur S., "Statistical Method in Educational Measurement," World Book Co., Yonkers, N. Y., **1925**, pp. 145–6.

[11] Norsworthy and Whitley, "Psychology of Childhood," Macmillan, New York, **1923**, p. 115.

[12] Skinner, E. S., Gast, T. M., and Skinner, H. C., "Readings in Educational Psychology," D. Appleton & Co., New York, **1926**, p. 514.

of inquiry, and an ability to observe phenomena and to group them in logical sequence. Only a few pupils have this fundamental scientific mental background. The vast majority of pupils using a problem type of investigation in the laboratory not only are trying to learn chemistry, but they are also trying to carry the additional load of learning the untried scientific mode of thinking. Their chronological age shows them far from mature in intellectual ability. With their youth and inexperience, it is not surprising that many fail to accomplish either the learning of chemistry or the new habit of thinking.

That some classes have succeeded in the "laboratory first" method as shown in the immediate test (Table IV) is possibly due to preparation in earlier years, or possibly, through efforts of the teacher in charge, a scientific mode of attacking problems was developed before the beginning of this experiment. It is self-evident that success in the "laboratory first" method requires a training in scientific thinking before the pupils can be expected to develop experiments through their own initiative and this, in turn, necessitates a special training on the part of the teacher.

Since the "laboratory first" method is closely related to the "individual" method of teaching chemistry, it seems fitting at this point to quote from the excellent report prepared by Horton[13] in 1928. He says, "It appears that we have over-emphasized individual work as a means of acquiring information and of merely understanding chemistry. On the other hand, there seem to be important outcomes from individual work, measurable and attainable by suitable methods which may make it more, rather than less, important."

The development of scientific attitude through the problem method in chemistry is highly desirable, and the writers believe that a part of the time allotted to chemistry in the high school should be given to education in this phase of learning. Since there is "a physiological, or theoretical, limit set by nature for every skill and capacity possessed by an individual,"[14] the load of learning should be adjusted within the limits where individuals of high-school age are able to learn and to retain both the subject matter of chemistry and the scientific method of attacking problems. It seems advisable either to increase the number of hours devoted to chemistry required in the curriculum or to decrease the amount of material in the course of chemistry required in accredited schools in order that pupils may have time to develop scientific methods of study. To quote Dewey: "The problem of problems in an education is to discover how to mature and make effective this scientific habit."[15]

[13] Horton, R. H., "Measurable Outcomes of Individual Laboratory Work in High-School Chemistry," *Teachers College Contributions to Education*, No. **303** (1928).

[14] Sandiford, Peter, "Educational Psychology," Longmans, Green & Co., New York, **1929**, p. 217.

[15] Dewey, John, *Science*, **31**, 127 (1910).

Summary

The results of this research have shown that, in the experimental classes described where fairly normal school conditions have been maintained,

1. For the total population tested the "recitation first" method is somewhat superior to the "laboratory first" method of teaching.

2. For the pupils in equated groups of the upper quartile the "laboratory first" method shows a superiority in the immediate test and the "recitation first" method, a superiority in the delayed tests. Both methods seem to work about equally well for bright pupils. For the students of the lower quartile, the "recitation first" method gives better results.

3. For both upper and lower quartiles, as well as for the total population, retention is greater following the "recitation first" method than following the "laboratory first" method.

4. A teacher's preference for a method has an influence upon his success in teaching by experimental procedures.

5. The size of school has less effect upon comparative mean percentage scores than was predicted.

6. The coefficient of correlation for the immediate test used with scholastic averages for the total population tested was 0.523, and that for the immediate test with the delayed test was 0.757.

7. A plan has been described whereby a coöperative research on methods of teaching has been carried through to completion by a group of teachers widely separated geographically in the state of Illinois.[16]

The writers wish to express thanks and appreciation to The Chemical Foundation, Inc., for financial aid in this research, and to Dean Charles E. Chadsey, Professor Walter S. Monroe, and Professor B. S. Hopkins for their interest and encouragement during its progress.

[16] The teachers coöperating with the writers were as follows: R. R. CAMMACK, Marion; J. C. CHIDDIX, Normal; ORSON CROXTON, Watseka; H. W. GARNETT, Bloomington; G. C. HICKLE, Jacksonville; L. J. HILL, Litchfield; WILLIAM HOLST, Granite City; WALDO HORRABIN, Western Illinois State Teachers' College, Macomb; ELIZABETH LONGBONS, Harrisburg; ALETA MCEVOY, Rockford; H. C. MOOR, Robinson; H. L. OLSSEN, Elmhurst; J. F. PINKERTON, Rushville; JESSE SHIDLER, Fairbury; D. M. SIMER, Decatur; SISTER LOUELLA, Bloomington; W. G. TILBURY, Paxton; C. D. TOMECKO, Bourbonnais; ROBERTA WHITNAH, Roanoke; MAX WOODWORTH, Pittsfield.

Quantum Theory Wins Another Victory. Quantum mechanics, one of the latest developments in physics, won another victory over the older ideas of physics when Dr. Philip M. Morse of Princeton and the Bell Telephone Laboratories reported recently to the National Academy of Sciences that the quantum mechanical theory of the electron, the particle of matter and electricity, explains not only the general effect of scattering of electrons when they are shot at crystals, but also small peculiarities in the experimental results that appear when electrons are considered to be just like X-ray beams in their action.—*Science Service*

AN INVESTIGATION OF STUDY METHODS USED BY HIGH-SCHOOL CHEMISTRY STUDENTS

OTIS A. CROSBY, WESTERN SENIOR HIGH SCHOOL, DETROIT, MICHIGAN

Many illuminating and startling articles have appeared concerning the college freshman chemistry student entering with one year's credit in high-school chemistry. Has the student been benefited by his early training in this science? The generalized conclusion seems to be a negative one and yet what is the cause? Has a year's work been ruthlessly wasted? Is it due to poor presentation, inefficient textbooks, inadequate equipment? Possibly so, but let us see just how the student has studied the lessons which have been assigned under the present tutelage and existing conditions.

To this end a questionnaire containing twenty-five questions covering practically every phase of the study of chemistry was circulated among 170 students of chemistry in one of Detroit's oldest high schools. The classes in which these students recited were under the supervision of three different instructors. The students were asked to sign the questionnaire but with the understanding that the information therein disclosed would in no way be connected with their grades. It was presented purely as a piece of minor research in which they were to furnish the virgin information. Due to the length of this article not all questions will be repeated.

In response to the statement, "*On an average I spend in the preparation of my chemistry lessons* (*a*) *about 15 minutes*, (*b*) *one-half hour*, (*c*) *one hour*, (*d*) *one and one-half hours*, (*e*) *two hours*, (*f*) *more than two hours*," it was found that 10 students spend 15 minutes, 78 one-half hour, 62 one hour, and 5 one and one-half hours. One hundred say they read the lesson twice, 39 once, and 23 three times.

One-half the students indicate that they study chemistry in the same manner they study other subjects. 30% say they make a daily outline; 21 study chemistry in the A.M., 33 the P.M., 61 in the evening, and 42 whenever convenient. The vote was 50-50 concerning the difficulty of studying at home.

To the query "*Do you often notice application of the subject matter, e. g., movies, advertisements, etc?*" 137 replied in the affirmative and 25 in the negative. The count was 2–1 in "*Do you underscore the text?*" Perhaps one of the outstanding disclosures came in answer to the question "*Do you really think the laboratory exercises helped you to better understand the text?*" 146, yes, 24, no. The same number reported likewise concerning the value of pictures in text.

Again, 132 say they benefited materially from student reports in class while 24 say no.

To illuminate the much-discussed problem of the value of laboratory work the following question was asked: "*Do you think you would learn more from the experiment on oxygen by having the instructor demonstrate it*

in class than by performing it yourself in the laboratory?" 102 say lecture-demonstration while 59 choose the laboratory.

The opinion was 3–1 that reason predominates over memory in chemistry. 79 students have a definite time for studying their lesson while 82 study whenever convenient. 111 say they study the questions at the end of the chapter while 52 do not. Regarding the reading of chapter summaries, eight students maintain that they read them before they read the chapter, 10 during the reading of the chapter, 131 after having read the chapter, 7 whenever they don't have time to read the lesson, and two students say they never read them.

In conclusion the writer desires to call attention to the number of dissenting or adverse opinions cast in the matter of several questions. It appears that 24 students throughout practically the entire set of questions have given adverse answers. By means of the student's names appearing on each paper the final grade of that student was secured from his respective instructor, thus making possible a check-up and it was found that with but two exceptions these opinions were cast by failing students. Likewise a check on the students that indicated they studied one and one-half hours, read the lesson twice and made daily outlines, etc., showed "B" or "A" students.

In view of these findings it would seem the interrogative conclusion would follow: Is it a matter of "how to study" as much as merely a matter of "study"? For apparently many failing students do not devote more than a few minutes each day to the preparation of their chemistry lesson.

Try to Toughen Skin against X-Ray Doses. Experiments to toughen the skin or decrease its sensitivity to X-rays, which are being made in the hope of increasing the amount of radiation used for treating tumors of the body, were described by Dr. Edith H. Quimby and Dr. George T. Pack of New York City at the recent meeting in Toronto of the Radiological Society of North America.

In treating deep tumors by radiation, either X-ray or radium, the rays must pass through skin and normal tissues before reaching the diseased ones, Dr. Quimby explained. The amount that can be used in treatment is limited by the amount the skin will tolerate. This amount is frequently not enough to have the desired effect on the tumor.

One method that gave satisfactory results was that of using combinations of different types of radiation in treating cases, rather than relying on a single type. The method was checked by the use of physical instruments which measured accurately the constancy of the radiation dose given.

The effects produced on the skin with a constant quantity of radiation were estimated in 100 tests. It was found that it took one-third more radiation to produce a mild effect on the skin when both hard and soft X-rays and hard and soft radium rays were used in equal proportions than when either one alone was used. This demonstrated a real increase in skin tolerance which could not be explained on purely physical grounds, Drs. Quimby and Pack concluded.—*Science Service*

LECTURE EXPERIMENT ON THE INFLUENCE OF THE SOLVENT ON THE SPEED OF REACTION

H. S. VAN KLOOSTER, RENSSELAER POLYTECHNIC INSTITUTE, TROY, NEW YORK

In looking for a simple reaction which might be made the basis for a classroom experiment to demonstrate the rôle of the solvent in chemical reactions the writer examined a number of texts which deal with this particular topic. Nernst,[1] in his "Theoretical Chemistry," first published in 1893, describes Menschutkin's[2] experiments on the velocity of reaction between ethyl iodide and triethylamine in several organic solvents. Later publications likewise refer to these investigations. Some recent textbooks on physical chemistry, published in 1924, still refer to these nearly forty-year-old studies without mentioning the accurate work of von Halban[3] (1909) on the decomposition of triethylsulfine bromide in a number of organic solvents in which von Halban found, contrary to the conclusions of Menschutkin, that there is no parallelism between the values of the velocity constant and the dielectric constants of the solvent media.

The rôle of the solvent in influencing reaction velocities has been made the object of extensive researches by Norris[4] and his co-workers (1925–29). Norris has coined a new word "adjuvance" to designate the influence of the solvent on reaction velocities. There are very few reactions that are suitable to illustrate this adjuvance in the classroom. Some time ago the writer came across a reaction which can be successfully used for this purpose—the formation of monobromacetone by the action of bromine on acetone (in excess) as expressed by the equation:

$$Br_2 + CH_3COCH_3 = CH_3COCH_2Br + HBr$$

This reaction has been studied in aqueous solutions by a number of investigators: Lapworth[5] (1904–1908), Dawson[6] (1909–1914), Rice[7] (1925), and Watson[8] (1927). With the exception of a few qualitative experiments by Lapworth, no detailed study has been made of this reaction in organic solvents. At the suggestion of the writer, Irving Cohen has made a quantitative study of this reaction in carbon tetrachloride, chloroform, and carbon bisulfide. In these solvents, none of which is acted upon by bromine, the bromination of acetone proceeds much faster than in water. In the course of Cohen's researches, which will be published elsewhere, it was found that traces of water retard the speed of reaction (in CCl_4) quite ap-

[1] Nernst, "Theoretische Chemie," F. Encke, Stuttgart, **1893,** p. 574.

[2] Menschutkin, *Z. physik. Chem.*, **6,** 41 (1890).

[3] von Halban, *Ibid.*, **67,** 129 (1909).

[4] Norris, *J. Am. Chem. Soc.*, **47,** 837 (1925).

[5] Lapworth, *J. Chem. Soc.*, **85,** 30 (1904); **93,** 2163, 2187 (1908).

[6] Dawson, *Ibid.*, **96,** 1860 (1909); **98,** 2148 (1910); **101,** 1503 (1912); **105,** 1893 (1914).

[7] Rice, *J. Am. Chem. Soc.*, **47,** 379 (1925).

[8] Watson, *J. Chem. Soc.*, **1927,** 3065.

preciably. As a lecture demonstration, the solvent action of water and that of carbon tetrachloride can be readily compared as follows:

A test tube with 20 cc. of a freshly prepared, saturated, aqueous solution of bromine is placed in a test-tube rack next to another tube containing 20 cc. of a solution of bromine in carbon tetrachloride diluted with the solvent to such an extent that the color and hence the concentration of the bromine is very nearly alike in both test tubes. On the addition of 5 cc. of pure acetone to each solution (with shaking to insure homogeneity) no perceptible change is noted in the aqueous solution for several hours while decoloration is observed in the organic solvent in less than 15 minutes, the time depending upon the amount of moisture in the solution. At the outset, the change in color is hardly noticeable but once it is well under way, the decoloration proceeds rapidly to completion (frequently progressing from the top toward the bottom) in the course of a few seconds. It should be noted that the decolorized solution on standing slowly turns yellow probably due to a secondary reaction. The aqueous solution, however, remains perfectly colorless after the bromine has disappeared. With a carefully dried solution of bromine in carbon tetrachloride and pure acetone, it can be shown that in the absence of water the velocity of reaction is greatest.

Should You Use Movies for Teaching? The answer depends not so much on the movies as on yourself and the methods you use. Unless you are willing to use them as a tool and take the trouble of adapting them to your classroom work it is doubtful whether you will find them much help. But if you will take as much trouble in locating films as you do in reviewing new texts and looking up references you will find them definitely helpful. If you make your own films they will be just as valuable as you care to make them.

The amateur standard 16-mm. film is the best for any one making his own picture because of the low cost of taking films. It is doubtful if illustrations can be made as cheaply on lantern slides as on 16-mm. films.

If you teach biology, motion pictures will provide you with lecture material regardless of the season. Your collecting can and cyanide bottle provide specimens for laboratory study but this material will not show your classes insects as they appear in life, or plants and flowers where you found them.

The teacher who takes his own films has the advantage of knowing exactly the use they are to be put to. They are taken to fit precisely into a schedule. They make their point by giving the exact interpretation intended in the illustration.

If you teach physics or chemistry, films will allow you to bring into the classroom interesting applications from the fields of industry. Geysers may be made to spout, turbines turn, chemicals crystallize, blast furnaces blow.

Whatever you teach, if you make use of illustrations, films will be a help in your work. But you must take them seriously. You must edit them for subject matter as carefully as you would written matter. You must select them as carefully as you would specimens for demonstration. You should be as sure of them carrying their point as you are of an experiment planned for the lecture table.—*Educational Screen*

THE NUMERICAL SOLUTION OF EQUILIBRIUM PROBLEMS

HORACE G. DEMING, UNIVERSITY OF NEBRASKA, LINCOLN, NEBRASKA

Textbooks of physical chemistry leave us in the dark regarding the best method to follow in finding numerical solutions of equilibrium problems. The following procedure will apply even to the most complex cases, where the equilibrium proportions are to be calculated from the equilibrium constant.

Let

$$\pi = (a_1 + s_1x)^{s_1}\,(a_2 + s_2x)^{s_2}\,(a_3 + s_3x)^{s_3} \qquad (1)$$

in which a_1, a_2, a_3, . . . express the number of moles of each substance originally present in the reaction mixture, while s_1, s_2, s_3, . . . express the number of moles of each substance that appear in the chemical equation. The values of s_1, s_2, s_3, . . . are to be taken as positive if they relate to substances in the right-hand member of the chemical equation, and negative in the contrary case. We shall let x represent the number of moles of any resultant that would have been produced by the reaction *if one mole of that resultant appeared in the right-hand member of the chemical equation.* π may be called the *mole-product.*

Let

$$K_p = \pi \left(\frac{P}{n}\right)^s \qquad (2)$$

in which K_p is an expression that becomes identical with the equilibrium constant, expressed in partial pressures, whenever the reacting substances are present in equilibrium proportions; while $s = s_1 + s_2 + s_3 + \ldots$, namely the sum of the exponents in the mole-product or equilibrium constant; $n = (a_1 + s_1x) + (a_2 + s_2x) + (a_3 + s_3x) = \ldots$, namely the sum of all the moles in the reaction mixture; and P represents the sum of the partial pressures of the individual components.

Now let a reaction take place, which would produce a slight additional amount, dx, of any resultant, if one mole of that resultant appeared in the chemical equation. Then, since $dn = s\,dx$,

$$\frac{d \ln K_p}{dx} = \left(\frac{s_1^2}{a_1 + s_1x} + \frac{s_2^2}{a_2 + s_2x} + \frac{s_3^2}{a_3 + s_3x} + \ldots\right) - s^2/n \qquad (3)$$

or,

$$dx = \frac{2.3}{Z - s^2/n} \cdot d \log_{10} K_p \qquad (4)$$

in which Z is the sum of the quantities formed by multiplying the reciprocal of the moles of each substance by the square of the exponent of that substance, in the mole-product or equilibrium constant. For example, in the first approximation below, the value of Z is roughly 4, while the total number of moles is $n = 95$, and the sum of the exponents is $s = -1$. The term s^2/n may usually be neglected, since n is usually large in comparison with the denominators of the terms that compose Z. When

the sum of the exponents is zero, or when the reaction is carried out at constant volume, the small term s^2/n vanishes altogether. We may replace K_p in the preceding formula by K_x, the equilibrium constant expressed in terms of mole fractions; or by K_c, the equilibrium constant expressed in terms of concentrations.

Calculate the composition at equilibrium (480°C. and a constant pressure of 720 mm.) of a mixture originally containing 25 moles of HCl and 75 moles of O_2. $K_p = 11.92$, or log $K_p = 1.07628$.

The large numerical value of K_p shows that the equilibrium mixture must contain considerable amounts of Cl_2 and H_2O. As a first approximation, assume that 20 moles of HCl react with 5 moles of O_2, to form 10 moles of Cl_2 and 10 moles of H_2O. From the concentrations then present we may calculate, by equation (2):

$$\log K_1 = \log \frac{10^2 \times 10^2}{5^4 \times 70} + \log 95 - \log 720/760 = 1.36022$$

This exceeds the desired result by $1.36022 - 1.07628 = 0.284$ unit. To correct it we must make $d \log K_p = -0.284$. We then roughly estimate $Z = 4$, and $2.3/Z = 0.6$, whence by (4)

$$dx_1 = 0.6 \times (-0.284) = -0.17$$

The negative sign indicates that we *decrease* the substances on the right-hand side in such a proportion as to increase the oxygen by 0.17 mole. Thus we arrive at a second approximation, tabulated below, from which we may calculate $\log K_2 = 1.07835$. This is too large by about 0.002 unit, hence we may calculate

$$dx_2 = 0.6 \times (-0.002) = -0.001$$

which enables us to make a slight final adjustment that gives the moles at equilibrium to the nearest thousandth of a mole.

	$4HCl$	$+ O_2 \rightleftharpoons$	$2Cl_2$	$+ 2H_2O$	$s = -1$	
Moles at start	25	75	0	0		
First approx.	5	70	10	10	$n = 95$	$\log K_2 = 1.36022$
Second approx.	5.68	70.17	9.66	9.66	$n = 95.17$	$\log K_2 = 1.07835$
Final result	5.684	70.171	9.658	9.658	$n = 95.171$	$\log K_3 = 1.07679$

The great advantage of this or any other iteration method is that slight accidental errors or the use of rounded values in approximation do not vitiate the final result, but at worst merely delay the convergence. In the present method it is usually sufficient to make a rough estimate of Z, mentally, or with a slide-rule. Problems in which the equilibrium constant is expressed in terms of the degree of dissociation may be solved in a similar way. If the initial concentrations appearing in a problem may be expressed in round numbers of moles, or if slide-rule accuracy is sufficient, it may be best to calculate and approximate K_p rather than log K_p.

In this case the adjustment to be made in the approximate value of K_p may be found by a formula derivable from (4), *viz.*,

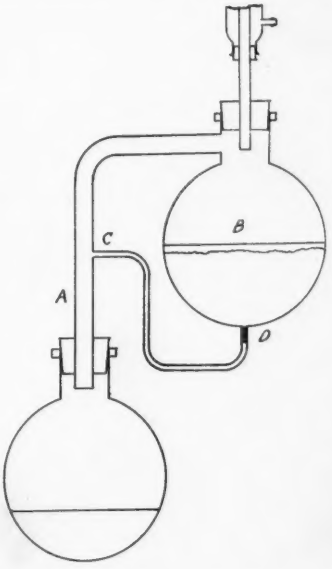
$$dx = \frac{1}{KZ} \cdot dK_p, \qquad (5)$$

in which K is the average of the approximate and true values of K_p. In the preceding example, the calculated first approximation for K_p is 22.9, as compared with the true value 11.9. Therefore, $dK_p = -11$, $K = 17.4$, $Z = 4$, whence $dx = -0.16$, in close agreement with the value -0.17, obtained as a first adjustment by the other method. The second approximation will nearly always give the desired solution within the limits of experimental error.

A CONTINUOUS EXTRACTOR FOR SOLIDS

JOHN H. GARDNER AND EDWARD B. W. KERONE, WASHINGTON UNIVERSITY, ST. LOUIS, MISSOURI

A recent description of an automatic continuous percolator[1] suggested a simple device for the continuous extraction of solids which can be readily and cheaply constructed by any one with a moderate knowledge of glass-blowing. The only materials necessary are a one-liter round bottom Pyrex flask, about two feet each of 15-mm. and 7-mm. Pyrex tubing, and a little glass wool. The wide tube A is sealed to the flask B at the neck and is bent at right angles about 19 cm. from the flask. The smaller tube leads down from the bottom of the flask and is bent around to connect with A at the point C, slightly above a line drawn through the center of the flask. A plug of glass wool is inserted at D. For use, the extractor is connected with a flask of solvent and a condenser as shown and the flask B is about half-filled with the solid to be extracted. The solvent is distilled into B, returning through D. The rate of flow can be regulated by loosening or tightening the glass wool plug. The efficiency is somewhat improved if the wide tube A is wrapped in asbestos.



[1] Jalade, *Ann. fals.*, **22**, 396–405 (1929); *Chem. Absts.*, **23**, 5272 (Nov. 10, 1929); see THIS JOURNAL, **7**, 685 (Mar., 1930).

A REVIEW OF SOME APPLICATIONS OF THE CANNIZZARO REACTION TO ALIPHATIC ALDEHYDES

ROBERT C. ELDERFIELD, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS

In the more popular of the current textbooks of organic chemistry, the group of compounds comprising the aldehydes are more or less sharply divided into two classes in the consideration of their deportment toward alkaline reagents. Aromatic aldehydes and those aliphatics with no alpha hydrogen, such as benzaldehyde, formaldehyde, and glyoxal, when subjected to the influence of alkali undergo what is known as the Cannizzaro Reaction—simultaneous oxidation and reduction of two molecules of the aldehyde with the formation of one molecule each of the corresponding alcohol and acid; the rest of the aliphatics condense with each other with the formation of aldols. Doubtless this differentiation has much to commend it from a pedagogical point of view, but, at the same time, the fact that typically aliphatic aldehydes can be made to display a behavior completely analogous to that of their aromatic prototypes appears in danger of being overlooked. To be sure, experimental conditions have to be modified somewhat in order to take into account the increased reactivity and tendency toward aldol formation consequent to the presence of an alpha hydrogen atom. But, when such allowances have been made, no intrinsic difference between the two classes is apparent, however striking may be the differences in degree. With the object of bringing out this capability of aliphatic aldehydes of undergoing the Cannizzaro Reaction, the following summary of the literature bearing on the subject is presented.

The first instance of the observation of the action of an alkali upon a truly aliphatic aldehyde appears to have been that of Fittig[1] on valeraldehyde and heptaldehyde—eleven years before the discovery of the aldol condensation by Wurtz. He found that the former on standing six to seven weeks at room temperature, or a few hours on the water-bath at 100°, with calcium oxide gave iso-amyl alcohol and iso-valerianic acid as chief products; heptaldehyde upon similar treatment gave heptyl alcohol and heptylic acid.

Between this time and 1898 several isolated investigations were undertaken, chiefly upon iso-butyric aldehyde. Pfeiffer,[2] Urech,[3] W. H. Perkin, Jr.,[4] and Urbain[5] studied the question, and their results, while not in complete agreement, did much toward clearing up the situation. In 1898, Franke and Kohn,[6] working with iso-butyric aldehyde carefully purified by

[1] Fittig, *Ann.*, **117,** 68 (1861).

[2] Pfeiffer, *Ber.*, **5,** 699 (1872).

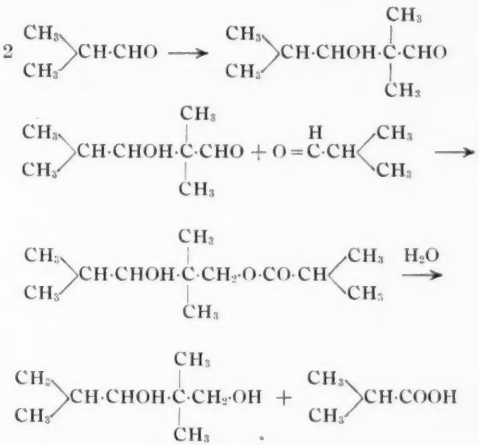
[3] Urech, *Ibid.*, **12,** 191, 1744 (1879); **13,** 483, 590 (1880).

[4] W. H. Perkin, Jr., *Ibid.*, **15,** 2802 (1882); *J. Chem. Soc.*, **43,** 90 (1883); *Ber.*, **16,** 210, 1029 (1883).

[5] Urbain, *Bull.* (3) **13,** 1048 (1895).

[6] Franke and Kohn, *Monats.*, **19,** 354 (1898).

depolymerization of the paraldehyde, reached the conclusion that under the influence of potassium hydroxide, its behavior may be represented:

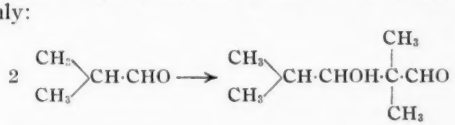


Thus the situation rested for three years when Lieben and Zeissel[7] attempted further clarification, and put forward what has come to be known as the "Lieben and Zeissel Rule." The aldehydes were divided into three classes, viz.:

I. *Those with a* CH_2 *or* CH_3 *group adjacent to the carbonyl group.* These first undergo aldolization, and then lose water to give unsaturated aldehydes:

$$2CH_3CHO \longrightarrow CH_3{\cdot}CHOH{\cdot}CH_2{\cdot}CHO$$
$$CH_3{\cdot}CHOH{\cdot}CH_2{\cdot}CHO \longrightarrow CH_3{\cdot}CH{:}CH{\cdot}CHO + H_2O$$

II. *Those with a* CH *group adjacent to the carbonyl group,* which undergo aldolization only:



III. *Those containing no alpha hydrogen.* These undergo a straight Cannizzaro Reaction of simultaneous oxidation and reduction:

$$2HCHO \longrightarrow CH_3OH + HCOOH$$

This generalization appears to have been retained intact in the contemporary texts.

[7] Lieben and Zeissel, *Monats.*, **22**, 289 (1901).

That very year a direct exception to this rule was noted.[8] Iso-butyric aldehyde, on heating with aqueous barium hydroxide in a sealed tube at 150° during the course of fourteen hours, is quantitatively converted to iso-butyl alcohol and barium iso-butyrate. Valeraldehyde exhibited a corresponding behavior. Shortly thereafter, iso-butyl alcohol and iso-butyric acid were found among the products formed on heating iso-butyric aldehyde with milk of lime at 150°.[9]

The Lieben and Zeissel Rule found itself in further difficulties when the discovery was made that very mild alkali, in the form of aluminum ethylate, without exception, induced the condensation of aldehydes, either aliphatic or aromatic, with the formation of esters.[10] As the mechanism of the Cannizzaro Reaction is ordinarily considered, this is the first step. Further work on this condensation has been plentiful in recent years.[11,12] Nord, by using mixtures of two different aldehydes, either two aliphatics or one aliphatic and one aromatic, obtained mixed esters under the influence of aluminum ethylate.[13]

Finally, this type of dismutation can be brought about by enzymes, first noted by Parnas.[14] Since then the enzymatic transformations of aldehydes have been the subject of somewhat exhaustive study. Euler and his co-workers[15,16,17] conclude that the reaction is a function of the hydrogen-ion concentration of the medium, occurring to some extent in the region around pH 3 to 4, but more rapidly in the vicinity of pH 7. Further a co-enzyme seems to be necessary. The dismutation of aldehydes is regarded as a process by which two molecules of the aldehyde are simultaneously bound in such a way that one component is richer in energy than the other. When rupture of this new molecule takes place, it will do so in accordance with this distribution of energy.

Thus it would seem that, contrary to the common impression, aliphatic aldehydes actually are capable of behavior similar to the aromatic ones, the reagent used to induce the Cannizzaro condensation having to be modified to a greater or less extent as befits the greater chemical reactivity of the former class. Otherwise there is no fundamental difference between the two.

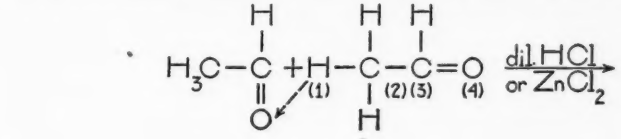
[8] Lederer, *Monats.*, **22,** 536 (1901).
[9] Herrmann, *Ibid.*, **25,** 188 (1904).
[10] Tischtschenko, *Centralblatt*, **1906,** II, 1309, 1554, 1556.
[11] Child and Atkins, *J. Am. Chem. Soc.*, **45,** 30 (1923).
[12] Verley, *Bull.* (4) **35,** 487 (1924); (4) **41,** 788 (1927).
[13] Nord, *Bioch. Z.*, **106,** 275 (1920).
[14] Parnas, *Ibid.*, **28,** 290 (1910).
[15] Josephson and v. Euler, *Zeit. Physiol. Chim.*, **135,** 49 (1924).
[16] Myrbäck and Jacobi, *Ibid.*, **161,** 245 (1926).
[17] v. Euler and Myrbäck, *Ibid.*, **165,** 28 (1927).

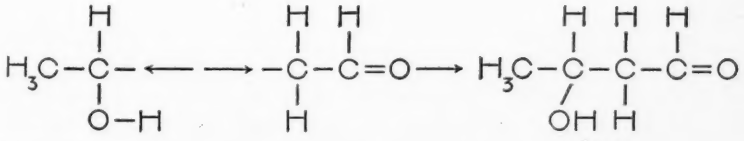
ALDOL AND RELATED CONDENSATIONS AS A TOOL IN TEACHING ORGANIC CHEMISTRY

HENRY PRICE HOWELLS, OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE, STILLWATER, OKLAHOMA

The large number of condensation reactions which must be studied in a course of organic chemistry are apt to burden the memory of the average student unless the instructor makes a serious attempt to correlate material in such a fashion as to simmer these condensations down to a comparatively few types. Considerable effort in this direction has been put forth by our textbook authors, and perhaps they have resorted to speculation at times to achieve a pedagogical end. In a similar manner here, it is intended as a means to an end to point out possible analogies among certain reactions, and to crystallize them about "aldol condensation" as a type in order that the student may have at least a helpful tool in his attempt to master these reactions.

As in the formation of aldol from acetaldehyde, the reactions with which we are concerned appear to take place between two particular types of groups or functions, (1) a labile hydrogen atom, usually alpha to a double bonded linkage, as the so-called Vorländer hydrogen[1] and (2) a more or less easily reduced unsaturated radical, usually a carbonyl group. These condensations may be considered as involving a compensating oxi-





ALDOL

[1] It is the experience of the author that the use of the more impressive term "Vorländer hydrogen" for an active alpha hydrogen atom is very stimulating to the student's interest in locating such atoms in particular structures. The "Vorländer Rule" is quickly presented to the student by writing the following series where E represents non-metallic

1 2 3 4 1 2 3 1 2 3 4 5

elements, H.E.E:E; H.E:E; H.E.E.E:E and pointing out that the hydrogen atom in the first member has a greater reactivity than that in either the second or third members. In the first case the double bond between two E atoms lies in the 3–4 position to the active hydrogen atom, just as the labile hydrogen in organic acids, phenols, imides, oximes, beta-ketonic esters, nitroparaffins, etc. If a more detailed discussion is needed here, see the original work of Vorländer, *Ber.*, **34**, 1633 (1901).

dation and reduction change, where group one (1) reduces group two (2) and the latter oxidizes the former. The compensating oxidation and reduction change giving rise to aldol may be represented by the mechanism illustrated by the reaction on page 597.

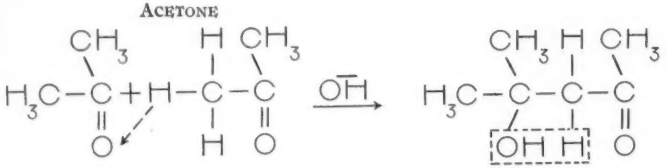
The alpha or Vorländer hydrogen atom marked by (1) apparently reduces an aldehyde carbonyl to an alcoholic hydroxide group and the carbon atom marked by (2) is simultaneously oxidized in the sense of losing hydrogen.

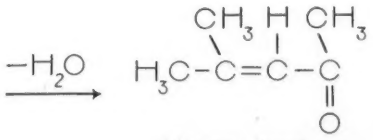
All aldol-like condensations may be divided here into three sub-groups; (1) the true aldol type, (2) the Claisen condensation type, (3) the Cannizzaro reaction type.

True Aldol

In the true aldol type the speed of reaction is often increased by a small concentration of hydroxide ion. However, a number of other catalysts may be at times more advantageous, such as hydrogen ions, H_2SO_4; HCl; $ZnCl_2$; $AlCl_3$; and $FeCl_3$. Acetone readily undergoes aldoling[2] in the presence of calcium hydroxide which gives a small concentration of hydroxide ion. It is doubtful whether many of us ever have used pure acetone, since even a trace of ammonia from the air may cause some "aldoling."

ACETONE



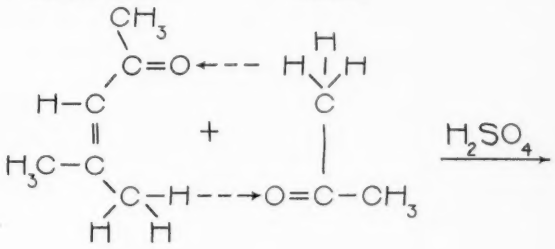


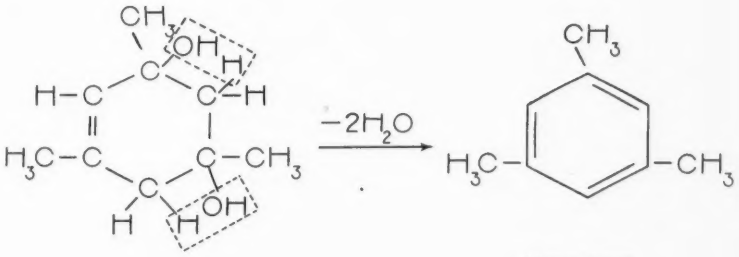
MESITYL OXIDE

When three molecules of acetone are condensed by means of concentrated H_2SO_4 to give mesitylene, the third molecule of acetone might be considered as aldoling with an intermediate mesityl oxide molecule.

[2] "Aldoling" is used throughout the paper for convenience only, and refers to a mechanism similar to that pictured for the compensating oxidation and reduction change giving rise to aldol on page 597. Thus the term will be used at times even when not referring to true aldol condensations.

MESITYL OXIDE ACETONE

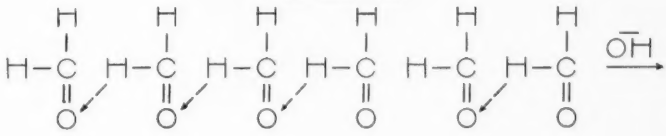


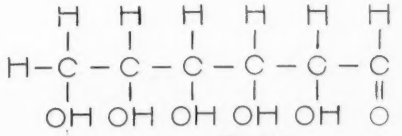


MESITYLENE

The formation of formose from six molecules of formaldehyde using a catalyst such as barium hydroxide is another classical example of aldol condensation. A much longer series of aldol condensations than that

FORMALDEHYDE

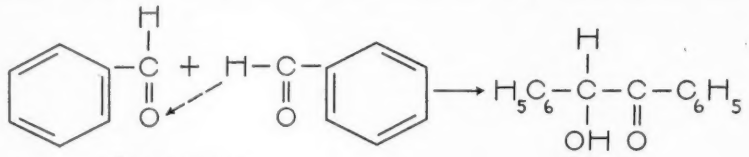




HEXOSE

in the case just cited gives rise to complex molecules of very high molecular weight, such as in bakelite and similar resins. The complex bodies may possess the same percentage composition as that of the simpler molecules.

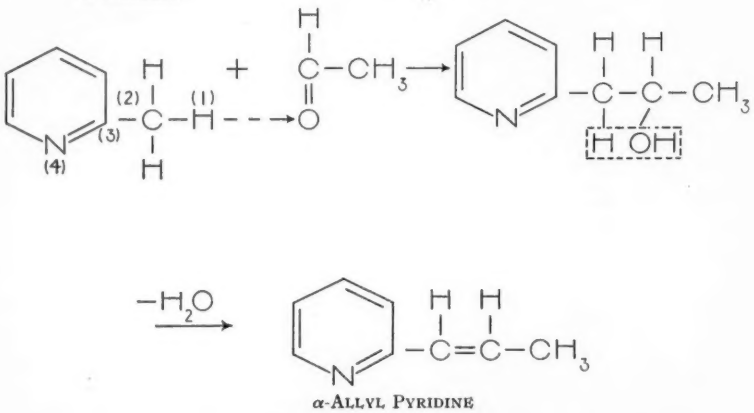
It is rather common to have aldoling between two aldehyde groups as is essentially the case in the above formation of formose. Other familiar examples of this kind are found in the furfuroin and benzoin condensation.



BENZALDEHYDE BENZOIN

A large number of reactions involve a reactive hydrogen alpha to a double or triple bonded nitrogen atom. An example of this kind is the formation of α-allyl pyridine from α-picoline and acetaldehyde, which is a step in the synthesis of γ-coniine.

α-PICOLINE



α-ALLYL PYRIDINE

The less familiar instances of quinaldine condensing with acetaldehyde to give α-allyl quinoline and with phthalic anhydride to yield quinoline yellow can be shown in a similar manner to the case just given.

Many other more or less common and important reactions can be represented as following the simple, compensating oxidation and reduction mechanism which is being presented. The list would be too extensive to demonstrate here, but after studying several of the following reactions as true aldol types one should then recognize other cases readily as they appear in the literature. In this study the student is recommended to first locate the reactive hydrogen, keeping in mind the Vorländer rule and the ideas of Smiles[3] when dealing with hydrogen present in structures

[3] Smiles, *Trans. Chem. Soc.*, **77**, 160 (1900).

like that of formaldehyde, ammonia, and acetylene. Smiles believes the structure demanded by the Vorländer rule is merely a reinforcing influence upon the lability of the hydrogen which already exists owing to the presence of an adjoining atom capable of showing a rise in valence. It must also be recognized early that every hydrogen in the benzene nucleus may be considered as Vorländer atoms.

Drill Suggestions on True Aldol

(1) Perkin-Fittig synthesis of unsaturated acids. (2) Skraup synthesis of quinoline. (3) Benzal and dibenzal acetone from benzaldehyde and acetone. (4) Phorone from acetone. (5) Phenylhydrazones, osazones, oximes, and semi-carbazones from aldehydes and ketones. (6) Formation of leuco-bases of various diphenyl and tri-phenyl methane dyes, including the phthaleins. (7) Formation of Schiff bases including intermediate products. (Basic catalysts favor usually the side chain for reactive hydrogen.) (8) Dimethyl fulvene from cyclo-pentadiene 1, 4, and acetone. (Include other fulvenes.) (9) Nitro alcohols and nitro olefines from nitro methane and aldehydes. (10) Ring closure of certain dialdehydes to form polymethylene derivatives. (11) Pseudo-ionone from citral and acetone. (12) Quinaldine from *o*-amino benzaldehyde and acetone. (13) Quinoline yellow from quinaldine and phthalic anhydride. (14) Hoesch synthesis of ketones from certain phenols and nitriles. (15) Furfuroin from furfural. (16) Resinification of aldehydes by alkalies (accounts partially for low yields in the synthesis of phenolic aldehydes by the Reimer-Tiemann method). (17) Inactive fructose from glycerose. (18) In general as a working hypothesis to explain the synthesis of fats in the plant kingdom and the conversion of sugars into fats in the animal body.

Claisen Condensation

The Claisen condensation type is essentially the aldoling in non-aqueous media of certain substances, many of which would give rise to entirely different products were the conditions for true aldol employed. The non-aqueous catalysts usually depended upon to effect the change are, (1) alcoholic sodium ethylate, (2) alcohol-free sodium ethylate, (3) metallic sodium, and (4) sodamide (freshly prepared). Among the more common reactions in this grouping are those used for producing—(1) beta-ketonic esters, *e. g.*, acetoacetic ester, (2) beta diketones, *e. g.*, acetyl acetone, and benzoyl acetone, (3) cyclic beta-ketonic esters from certain diacid esters.[4]

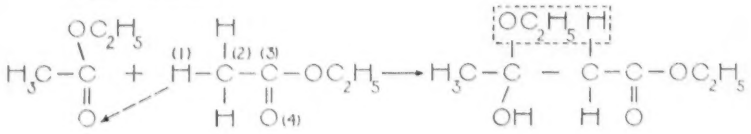
Since the preparation of substances in the first two of the three divisions are the most familiar examples, the following graphical illustrations should

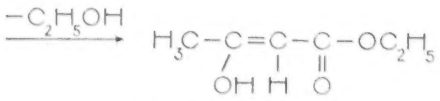
[4] Perkin and Titley, *J. Chem. Soc.*, **122,** 1562 (1922); McElvain, *J. Am. Chem. Soc.*, **46,** 1721 (1924).

be studied first, followed by a similar study of other cases found in the literature.

It appears that metallic sodium or sodium ethylate might catalytically effect the aldoling of two molecules of ethyl acetate, with subsequent elimination of a molecule of alcohol.

ETHYL ACETATE



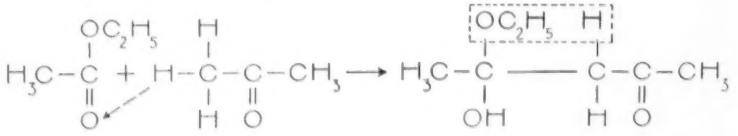


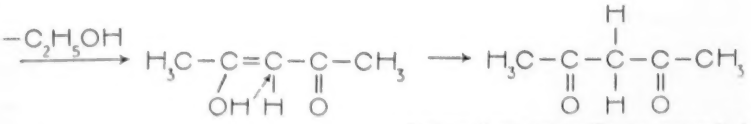
ETHYL ACETO ACETATE

Other esters of the aceto acetic ester type may be formed in the same manner by starting with other fatty esters, and eliminating a molecule of alcohol between the carbalkoxy group of one ester molecule and a hydrogen atom alpha to the carbonyl group in the other ester molecule which is entering into the reaction.

Beta-diketones, the preparation for which Claisen's condensation was originally designed, may be formed in much the same manner as aceto acetic ester by aldoling a fatty ester with a fatty ketone, with subsequent splitting out of alcohol.

ETHYL ACETATE ACETONE



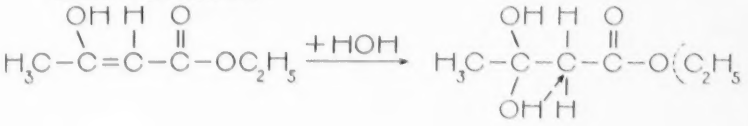


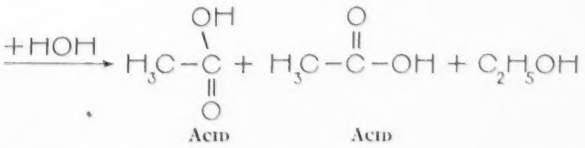
ACETYL ACETONE OR PENTANDIONE 2, 4

Reversed Aldoling

It is interesting to note here the effect which concentrated alkali has upon aceto acetic ester types, and to interpret these well-known cases of "acid" decomposition in the light of the present work. Usually this "acid" decomposition may be brought about by concentrated sodium hydroxide in alcohol. The mechanism of the change may be pictured as virtually "reversed aldoling,"[5] involving the addition first of a molecule of water to the double bond or the carbonyl group depending upon whether the enol or keto form is functioning.

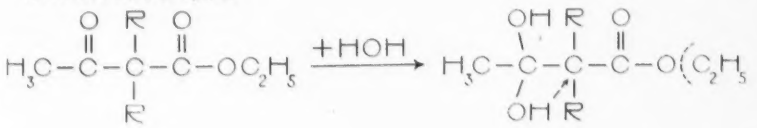
ETHYL ACETO ACETATE

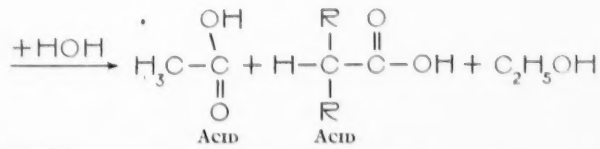




In the acid hydrolysis of di-alkyl acetic esters the preliminary addition of the molecule of water apparently takes place at the carbonyl group since no enol variety is possible.

DI-ALKYL ACETIC ESTER

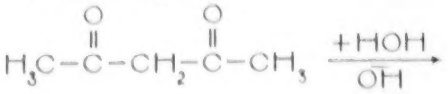


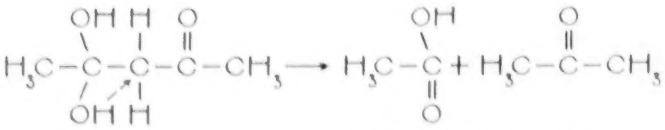


[5] If aldol condensation can be considered as compensating oxidation and reduction, "reversed aldol" could be looked upon perhaps as intramolecular oxidation and reduction.

"Reversed Aldoling" seems to be rather a general reaction and may be used as above in showing the decomposition of beta-diketones by alkali, as well as in explaining certain changes in terpene chemistry, such as the dealdoling of citral by refluxing it with aqueous potassium carbonate. Illustrations of the two changes just mentioned are given below in order.

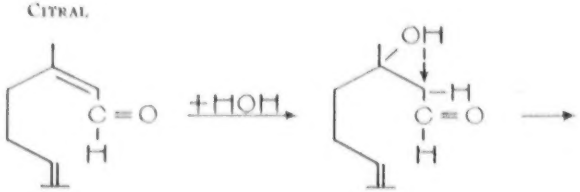
Pentandione 2, 4

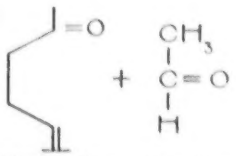




Acetic Acid Acetone

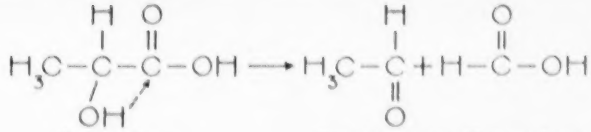
Citral





Methyl Heptenone Acetaldehyde

There are certain cases where the "reversed aldoling" does not involve the preliminary addition of a molecule of water. An example of this kind is the splitting of lactic acid by dilute sulfuric acid into acetaldehyde and formic acid. The reaction resembles the reverse of the reaction of its formation from acetaldehyde through the cyanohydrin by aldol condensation.



LACTIC ACID ACETALDEHYDE FORMIC ACID

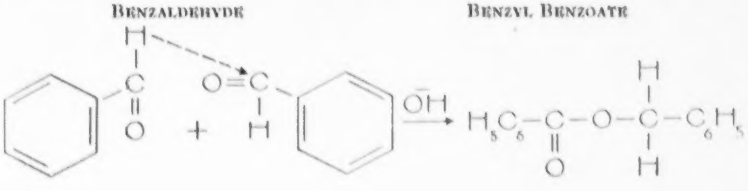
The Cannizzaro Reaction

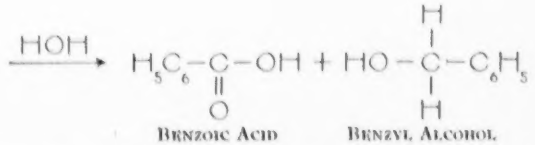
The Cannizzaro reaction involves a very special type of aldoling where two aldehyde groups mutually undergo a compensating oxidation and reduction change. The reactive hydrogen joins to the carbon of the reduced carbonyl group rather than to the oxygen atom. This reaction almost invariably runs parallel with true aldol condensations and vice versa.

Some factors such as a rise in temperature of the reaction mixture and high concentration of the hydroxide ion often favor the Cannizzaro type of change. The best-known cases of this important reaction are perhaps the formation of benzyl alcohol and benzoic acid by heating benzaldehyde in the presence of a high concentration of the hydroxide ion, and the production in a similar manner of furane α-carboxylic acid and furfuralcohol from furfural.

The ultimate result in the former reaction is an intermolecular oxidation and reduction, *i. e.*, the reduction of the second molecule of benzaldehyde by the first molecule and the oxidation of the latter by the second molecule to give benzyl alcohol and benzoic acid, respectively.

BENZALDEHYDE BENZYL BENZOATE





BENZOIC ACID BENZYL ALCOHOL

Claisen,[6] Kohn and Tranton,[7] and Lachmann[8] have demonstrated

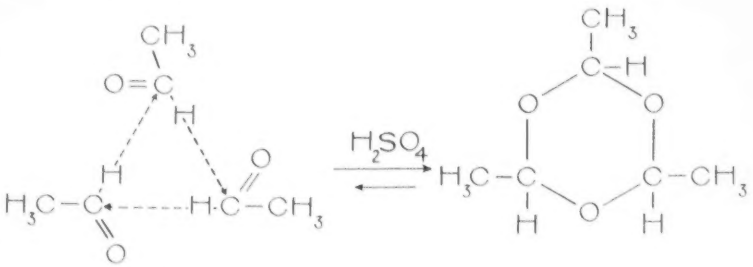
[6] Claisen, *Ber.*, **20,** 646 (1887).

[7] Kohn and Tranton, *J. Chem. Soc.*, **75,** 1155 (1899).

[8] Lachmann, *J. Am. Chem. Soc.*, **46,** 708 (1924).

beyond doubt that benzyl benzoate is an intermediate product in the above reaction. It is possible to extract the intermediate ester by carrying the reaction out under a layer of ether. It is also possible to stop the subsequent hydrolysis and obtain benzal benzoate as the main product by using absolute alcohol and sodium ethylate.

The polymerization of acetaldehyde in the presence of concentrated sulfuric acid to give paraldehyde may be shown to follow the Cannizzaro mechanism as follows.



ACETALDEHYDE PARALDEHYDE

The depolymerization of paraldehyde may be regarded as "reversed aldoling." This particular change is brought about usually by heating with dilute sulfuric acid.

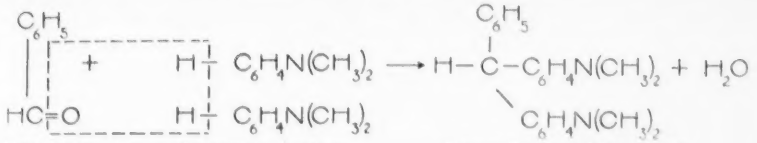
In "aldoling" and "dealdoling" it is rather common to use essentially the same chemical catalyst, which one might expect on a theoretical basis since the equilibrium of the reaction can be approached from either side.

The synthesis of methyl heptenone by the method of Barbier and Bouveault[9] affords a unique drill exercise on the last three main points presented. The Claisen type of change is used in obtaining one of the starting materials, namely acetyl acetone which is condensed with gem-dimethyl trimethylene bromide to give an unsaturated diketone, which on being heated with aqueous potassium carbonate takes up a molecule of water and undergoes "reversed aldoling" to give methyl heptenone and acetaldehyde. The latter substance yields acetic acid as a by-product through the Cannizzaro reaction.

Further Suggestions on the More Complex Reactions

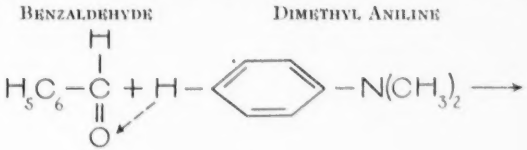
A few examples will be taken up next from the more complex chapters of general organic chemistry and analyzed in view of improving the method of presentation. First, a typical synthesis of a leuco base in the triphenyl methane group of dyes as it appears in most textbooks on the subject is reproduced here.

[9] Barbier and Bouveault, *Compt. rend.*, **122**, 393 (1896).

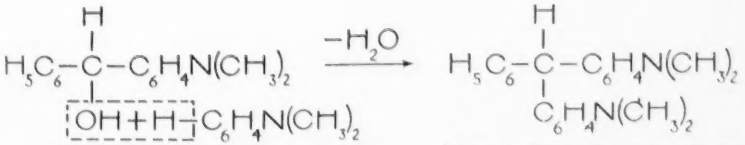


BENZALDEHYDE DIMETHYL ANILINE LEUCO BASE OF MALACHITE GREEN

Would it not be more instructive to point out that the formation of the above leuco base involves a compensating oxidation and reduction of the true aldol type brought about usually by certain catalytic reagents? Every hydrogen in the benzene nucleus is a Vorländer atom and is particularly sensitive to labilization by acid catalysts such as H_2SO_4, HCl, $ZnCl_2$, $AlCl_3$, and $FeCl_3$. Often the para hydrogen atom in benzene derivatives seems to function more like an active alpha hydrogen than those in other positions in the ring. In dimethyl aniline it is this para hydrogen which reduces the carbonyl group by aldoling with it. In the preparation

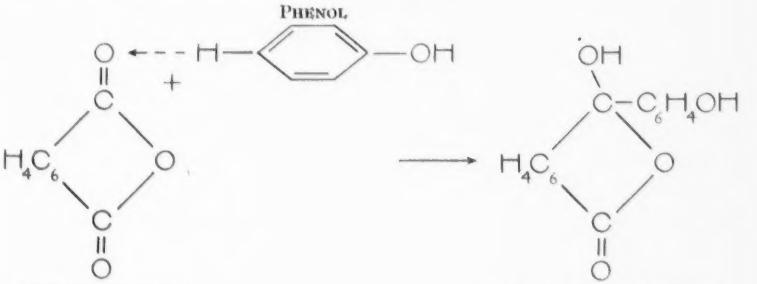


BENZALDEHYDE DIMETHYL ANILINE



LEUCO BASE OF MALACHITE GREEN

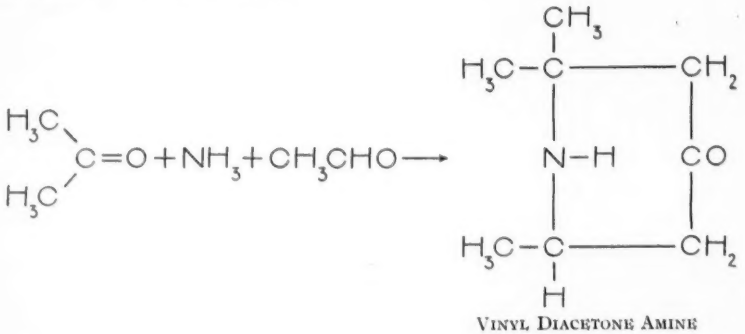
of the triphenyl methane dye, phenolphthalein, the formation of the intermediate carbinol may be represented as follows:



PHENOL

PHTHALIC ANHYDRIDE INTERMEDIATE CARBINOL

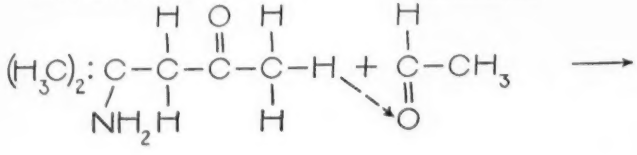
In the synthetic drug chapter one of the most important local anesthetics is β-eucaine which is made from vinyl di-acetone amine. The reaction for the preparation of the latter substance as taken from one of the popular texts is shown as follows:

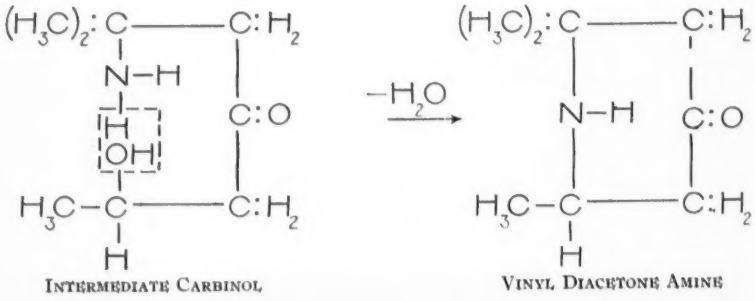


VINYL DIACETONE AMINE

It is believed that the above reactions can be presented in a more understandable manner when interpreted as involving aldoling. Diacetonamine can be shown as forming from the action of ammonia upon mesityl oxide which is formed by aldoling two molecules of acetone as illustrated on page 598. The next step is the aldoling of acetaldehyde with diacetonamine, which is followed by a dehydration, closing the chain to a piperidone ring structure called vinyl diacetone amine.

DIACETONE ANILINE ACETALDEHYDE





INTERMEDIATE CARBINOL VINYL DIACETONE AMINE

No doubt, due to the use of speculation in many of the foregoing derivations, discrepancies will appear as the mechanism of certain of the discussed reactions are studied further in the light of exact research. But it is doubtful that the facts revealed in such research could be incorporated into the teaching of organic chemistry and thus serve the student to the extent that the above correlations would in minimizing his memory requirements.

Artificial Atmosphere Found Better than Real Variety. Helium, the gas that makes the American non-inflammable airships possible, may prove of value in helping submarine crews to work more efficiently, if a suggestion made recently by D. J. Willard Hershey, of McPherson College, is adopted. Speaking before the chemists attending the recent meeting of the American Association for the Advancement of Science, he told of his study of artificial atmospheres. Some mixtures of gases, quite different from the mixture that forms the air we breathe, supported life of mice and guinea pigs even better than ordinary air, he discovered.

Natural air contains 21 per cent oxygen, 78 per cent nitrogen, and 1 per cent of a mixture of gases including carbon dioxide, helium, argon, krypton, neon, and xenon. One series of experiments on white mice showed that a mixture of nitrogen and oxygen, in the same proportion as in air, but without the other gases, only supported life for a few days. This demonstrated that the rare gases are necessary for life, said Dr. Hershey.

In pure oxygen, the animals lived only two to five days, while a similar group of animals, also kept in a large bottle with normal food supply, but supplied with ordinary air, suffered no ill effects whatever. With a mixture of 60 per cent oxygen and 40 per cent nitrogen, however, the animals lived as well as normally, if not better.

A mixture of 79 per cent helium and 21 per cent oxygen, practically ordinary air with the nitrogen replaced by helium, supported the life of mice in a normal manner. Using argon instead of helium and in the same proportion, the mice did not survive. Dr. Hershey pointed out that the argon mixture does not diffuse through the living cells as rapidly as natural air, while helium diffuses more rapidly. As the helium-oxygen atmosphere is considerably lighter than air, it would doubtless be possible for a person to live inside the gas bag of an airship containing it.

However, Dr. Hershey found that a mixture of 25 per cent oxygen and 75 per cent argon supported the life of mice, and that at the end of ten days in it, they appeared better than at the start.

"In the field of practical application of prepared atmospheres there is a wide range of commercial uses and values," said Dr. Hershey. "Medical men have a fair knowledge of the action of oxygen in the air, but nothing is understood by them concerning the other gases. It is quite possible that a knowledge of atmospheres may aid in the control of diseases.

"In deep-sea diving, mines, and in submarines, foul air is encountered and is not sufficient in amount to sustain life. A prepared atmosphere for such activities would broaden their respective range of usefulness. An artificial atmosphere in a submarine that sustained life even more effectively than the normal air would bring about a safer and more efficient submarine. A prepared atmosphere would be of great advantage to the high altitude flyer."

Dr. Hershey believes that the widest field of prepared atmospheres will be in the treatment of disease.—*Science Service*

OBJECTIVE TESTS IN ORGANIC CHEMISTRY*

J. W. Ince and Cecil L. Brown, Rhode Island State College, Kingston, Rhode Island

The use of objective or so-called "short answer" examinations in general chemistry is widespread. Considerable time and ingenuity are required to produce a test of this type that will be the measure one desires. The time involved, however, is compensated for by the ease and exactness obtained in grading the papers.

Objective tests for organic chemistry have found less application, possibly because the ways in which they may be applied have not been very apparent. It is the purpose of this paper to offer some suggestive samples of tests that have been used in organic chemistry.

For convenience the examinations, only portions of which are presented in this article, have been grouped under the general headings of (1) matching, (2) completion, (3) true-false, (4) multiple-choice, and (5) sequence types. It may be mentioned here that the tests represented have been designed to require ten to twenty minutes for answering. For rapidity in grading only one type has appeared on a paper. For longer examinations composites of these have been used.

Matching Type

Examples of the first or matching type are shown in Tests 1–4. In Test 2 the number of names is double the number of formulas. Test 4 shows only a part of the questions and of the possible responses.

Test 1

Match the item in the first list with the corresponding item in the second list by putting similar numbers in front of each pair.

Name		Formula
1. Propyl isocyanide	....	$(CH_3)_2CHCONH_2$
2. Iso butyramide	....	$(CH_3CH_2CH_2CH_2)_3N$
3. Tetra me ammon. hydroxide	....	$CH_3(CH_2)_2NC$
4. Tri *n*-butyl amine	....	$(CH_3)_4NOH$

Test 2

Formulas		Names		
1. C_6H_5Br	....	Cymene	....	Bromobenzene
2. $C_6H_5C_6H_5$	....	*o*-brom nitro benzene	....	Hexamethyl benzene
3. $C_6H_5CH_3$	....	Diphenyl	....	*p*-Xylene
4. $C_6H_4(CH_3)_2$ 1,4	....	*m*-chlor toluene	....	Toluene

Test 3

1. Acetone	....	Removes iron rust and ink spots
2. Bakelite	....	Chemical solvent
3. Ethylene glycol	....	Insulating material
4. Oxalic acid	....	Automobile antifreeze agent

* Presented before the Division of Chemical Education of the A. C. S. at Minneapolis, Minnesota, September 12, 1929.

TEST 4

From the list of substances below record in numerical order the numbers of those corresponding to the questions.

E. All those that are useful as a source of heat.
F. All those that are of interest or value in connection with the study of medicine.
G. All those that are useful as solvents.

1. Gasoline	5. Grain alcohol	9. Chloroform
2. Coal	6. Natural fats	10. Sterno
3. Benzene	7. Kerosene	11. Wood alcohol
4. Iodoform	8. Marsh gas	12. Coal-tar dyes

Completion Type

Examples of the completion type are shown in Tests 5–13.

TEST 5

Give structural formulas for the compounds represented.

The methane hydrocarbon containing	Corresponding alkyl radical	Halogen derivative	Alcohol	Aldehyde*	Ketone*
Two carbons					
Four carbons					

*To contain number of carbons corresponding to hydrocarbon named.

TEST 6

Give as many names as possible for the following formulas.

a. $CH_3CH_2CHCH_2CH_3$
CH_3

TEST 7

For each of the following formulas supply the specific name of the compound and the class represented by it.

	Formula	Specific name	Class name
a.	$CH_3CHOHCH_3$	.....	.....
b.	CH_2COOH CH_2COOH	.....	.....

TEST 8

Supply, in the space provided, the names of the reactions illustrated by the equations given.

$CH_3Cl + CH_3CH_2Cl + Zn \longrightarrow CH_3CH_2CH_3 + ZnCl_2$ .....
$CH_3CH_2COONa + NaOH \longrightarrow CH_3CH_3 + Na_2CO_3$ .....

TEST 9

Balance and complete the following equations:

$CH_4 + Cl_2 \longrightarrow$ .....
$CH_3COONa + NaOH \longrightarrow$ .....
$CH_3I + Zn \longrightarrow$ .....

TEST 10

Fill in all blank spaces with the name or formula corresponding to that given in the same horizontal line.

Common name	Chemical name	Structural formula
Acetylene	.....	.....
.....	Ethanol	.....
.....	.....	$CHCl_3$

TEST 11

Introduce formulas for the intermediate compounds.

Reactant	Intermediate	Product
CH_4	.....	CH_3OH
C_2H_5Br	.....	CH_3CH_2COOH

TEST 12

Supply in the space provided structural formulas of compounds which illustrate the term designated.

Terms	Compounds
Unsaturated hydrocarbon	.....
Alkyl group	.....
Halogen derivative	.....

TEST 13

In each of the following supply the missing words necessary to complete the meaning of the sentence.

1. Decomposition of a substance by heat with accompanying deposition of free carbon is known as.....
2. The majority of carbon compounds are practically insoluble in.....
3. Tests furnishing criteria of purity of organic substances are the determination of .....in the case of solids and of the.....in the case of liquids.

True-False Type

The use of true-false questions is exemplified in Tests 14–16.

TEST 14

Indicate by + correct answers; by − incorrect answers.

PART I. All asymmetric carbons are shown by *;

( ) $^*CHOHCOOH$ ( ) $^*CHOHCOOH$
$|$ $|$
CH_2COOH $CHOHCOOH$

PART II. The following pairs of compounds are isomers:

( ) CH_3CHCl_2 and $CH_2Cl—CH_2Cl$
( ) $(CH_2COOH)_2$ and $CH_3CH(COOH)_2$

TEST 15

( )	CH_3OH	Wood alcohol
( )	CH_3OCH_3	Ordinary ether
( )	$CH_3CH_2CHOHCH_3$	Tertiary butyl alcohol
( )	$CH_2CO \diagdown O$ $\cdot$ $CH_2CO \diagup$	Acetic anhydride

TEST 16

Mark an *x* over the number of incorrect statements.

1. An empirical formula represents merely the relative number of atoms of the elements present in a compound.
2. A graphic formula represents the supposed relationship or arrangement of the atoms present in a compound.

Multiple-Choice Type

Several representatives of the multiple-choice type appear below.

TEST 17

Draw a line through the correct statement.

1. Coke and charcoal are made by:
   destructive distillation; burning coal and wood; they are dug from the earth.
2. The refining of petroleum is a process of:
   destructive distillation; fractional distillation; cracking oils; filtering oils.

TEST 18

From each of the following groups of formulas select those that are identical in structure with the first formula in the group. Draw a line through those selected.

a. $CH_3CH_2CH_2CH_2CH_2CH_3$ *b.* $(C_2H_5)_2CHCH_3$ *c.* $CH_3CH_2CHCH_2CH_3$ (with CH_3 below the second C) $[(CH_3)_2CH]_2$

d. $CH_3CH_2CH_2CHCH_3$ (with CH_3 below the fourth C)

e. $CH_3{\cdot}C(CH_3)_2{\cdot}CH_2CH_3$ (with CH_3 below the first C and CH_3 below the second C)

f. $CH_3{\cdot}CH(CH_2CH_3){\cdot}CH_2CH_3$ (with CH_2 below the first C and CH_3 below the second C)

g. $(CH_3)_3C{\cdot}C_2H_5$

TEST 19

Compound	Method of preparation or manufacture
Grain alcohol	Hydrolysis, oxidation, reduction, or fermentation
Wood alcohol	Oxidation, fermentation, destructive distillation, or fractional distillation

TEST 20

1. Find the formula of that gas which contains 80% C and 20% H. (At. wts.: C = 12, H = 1).

Solution:

C = 80 ÷ 12 = 6.66
H = 20 ÷ 1 = 20

Answer. CH_4, C_2H_4, C_4H_{10}, C_2H_6, C_6H_{14}, C_6H_6, or C_2H_2.

2. Given the weight of one liter of propane gas at N. T. P. as 1.964 g. the molecular weight can be found by:

a. Dividing 1.964 by 1; *b.* Dividing 22.4 by 1.964;
c. Dividing 273 by 1.964; *d.* Multiplying 22.4 by 1.964;
e. Multiplying 1.964 by 44.

TEST 21

Draw a line through related expressions, synonymous with or suggested by corresponding term in first column.

—CONH—	Acid amide, benzene ring, peptid-linking, Van Slyke's test
Millon's reaction	Phenolic group, green ring, albuminometer, putrefaction of proteins
Xanthoproteic reaction	Red precipitate, protein classification, alkaloidal reagent, yellow color

TEST 22

Draw a line through the terms that are synonymous with, identical to, or related to the expressions given in the first column.

Carboxylic acids	Toluic acid, carbolic acid, sulfanilic acid, pyromucic acid, nicotinic acid
Racemizing agents	Copper sulfate, sodium hydroxide, quinoline, cinchonine

TEST 23

One name is incorrectly used in each of the following groups. Draw a line through this name.

I	II	III
$CH_3{\cdot}CH_2{\cdot}CH(CH_3){\cdot}C_2H_5$	$CH_3{\cdot}CH(OH){\cdot}CH_2{\cdot}CH_3$	$C_2H_5{\cdot}O{\cdot}CH_3$
Isopentane	Me et carbinol	Me et ether
Me di et methane	Secondary bu alcohol	Ordinary ether
Me isobu methane	Isopr carbinol	Me et oxide
Isohexane	Me et hydroxy methane	Methoxy ethane
Isobu ethane	Hydroxy butane (2)	A mixed ether

TEST 24

There is one incorrect formula or equation in each of the following questions. Draw a line through this incorrect answer.

1. These formulas represent members of the methane series of hydrocarbons:

a. C_5H_{12} *b.* $C_{10}H_{22}$ *c.* C_8H_{10} *d.* C_4H_{10} *e.* $C_{60}H_{122}$

2. These formulas represent esters:

a. $(C_2H_5)_2SO_3$ *b.* CH_3Cl *c.* $C_2H_5COOC_2H_5$ *d.* CH_3COCl *e.* $C_2H_5HSO_4$

Sequence Type

Two examples of the sequence type are given in Tests 25 and 26.

TEST 25

A. To produce butyric acid from the ethyl ester of malonic acid one may pass through these steps. Number them in order.

....Saponification ....Add Na
....Heat to remove CO_2 ....Add C_2H_5Br

TEST 26

A. To obtain pure crystals from some impure material these steps may be carried out. Number them in proper sequence.

....Melting-point determination ....Fractional crystallization
....Choosing solvent ....Removal of residual solvent
....Removal of insoluble impurities

These tests are of course only suggestive of the various modifications which the objective examination may take in organic chemistry. By analysis of the subject matter to be covered, practically every portion of this branch of chemistry can be included in questions of the above types.

Reducing Dust Hazard of Granite Industry. Removal of air at a speed of 1500 feet per minute, measured at the surface of the ventilating hood, is the standard for ventilating systems that will reduce the dust in the air of granite plants to a safe level, the U. S. Public Health Service has announced as the result of its studies just completed.

Dust in the various operations of the granite industry has long been a serious hazard to workers' health. The disease of the lungs known as silicosis was found to develop as a result of prolonged exposure to the granite dust through long periods of employment. Previous studies showed that when the air which the operator breathed had less than 10 million particles of dust per cubic foot of air, it was safe. Certain of the granite-cutting plants had ventilating systems which provided sufficient ventilation to make the plants safe for the workers when the systems were properly operated, the recent investigations showed.

Besides studying the ventilation systems in operation, the U. S. Public Health Service conducted an experiment to determine the exhaust velocity necessary at the ventilating ducts to keep the dust down to a safe limit. As a result of the experiment, the safe limit of exhaust velocity was determined to be 1500 feet per minute.—*Science Service*

THE RECOVERY OF IODINE AS SODIUM IODIDE FROM WASTE IODIDE SOLUTIONS

WALTER D. BONNER AND K. MASAKI, UNIVERSITY OF UTAH, SALT LAKE CITY, UTAH

Iodine is among the most expensive of the commonly used laboratory agents and its recovery, in a usable form, from laboratory wastes is a measure of real economy. For several years this laboratory has made it a rule to store waste iodide solutions and at periodic intervals to recover the iodine by precipitation with chlorine and filtering. The purification of the crude recovered iodine, however, and its conversion into its more useful form of iodide, was a decidedly troublesome matter. We finally hit upon the following method, which we believe is of interest sufficient to warrant publication.

Purification of Crude Iodine

Crude iodine as recovered from laboratory wastes contains shreds of asbestos, bits of filter paper, etc., in addition to chemical impurities. Since it is also wet, purification by the conventional method of sublimation is difficult and unsatisfactory. Moreover, it is not easy in the ordinary laboratory to arrange for the sublimation of quantities as large as a kilogram or more. We therefore have adopted a method of dissolving and reprecipitating. The crude iodine precipitated by chlorine is suspended in a convenient quantity of water, and sulfur dioxide passed in until the solution is colorless. This allows the insoluble material to be separated by filtration. The iodine is again precipitated by chlorine, filtered and washed by suction in a large Buchner funnel. This process of solution, filtration, and reprecipitation, is repeated until a sufficient purity has been attained. We have found that three precipitations, after the first recovery of the crude material, are usually enough. We found, for instance, that a sample treated in this way showed, on titration against standard thio solution, 95% iodine as contrasted with 93% iodine found in a sample of the resublimed product of one of the leading manufacturers of chemicals.

Conversion into Sodium Iodide

The conversion of the purified iodine into sodium or potassium iodide is a more troublesome matter than is the purification of the iodine. It cannot be done by direct treatment of the iodine with alkali hydroxide because of the large amount of iodate formed at the same time. Direct conversion of the iodine into pure hydriodic acid is very difficult, if not impossible. We therefore dissolve the iodine as before with sulfur dioxide. This gives a solution of hydriodic acid, together with an equivalent amount of sulfuric acid, as shown by the equations:

$$I_2 + SO_2 + 4H_2O \longrightarrow 2HI + H_2SO_4$$

It will also contain sulfurous acid, being saturated with SO_2. The volume of this solution is measured, and a sample titrated with a standard alkali.

One hundred cc. of this solution are reserved for later use, and the remainder neutralized with pure lime. The lime should be weighed out, carefully slaked, and the milk of lime added slowly to the acid solution. This converts the various acids into the corresponding calcium salts, most of the calcium sulfate and calcium acid sulfite being precipitated while the calcium iodide remains in solution. This mixture is allowed to stand at least an hour or two with frequent shaking or, better, with continual stirring. After enough time has elapsed to insure a complete reaction, the mixture is filtered and the precipitate carefully washed free from iodide. This residue can then be discarded. The filtrate contains the iodine as calcium iodide, along with small amounts of calcium sulfate or bisulfite and possible excess of lime. In order to determine the amount of excess lime, should any be present, the volume of the solution is measured and an appropriate sample, for example 10 cc., taken. To this is added an excess (0.25–0.50 g.) of alkali iodate and the solution titrated with standard acid until the color of iodine appears. This titration is based on the fact that iodide ion and iodate ion do not react unless hydrogen ion also is present. When enough acid has been added to neutralize the excess alkali, the next drop starts the reaction between iodide and iodate. The appearance of iodine is thus the indication of the end-point of the titration. The excess alkalinity is calculated and adjusted by means of the 100-cc. portion previously reserved for this purpose. The next step is to remove the small amount of sulfate which remains in the solution in the form of calcium sulfate. This is done by adding a solution of barium iodide until no further turbidity is produced. The total iodide in the solution is now determined preferably either by titration with a standard silver nitrate or by titration with iodate in the presence of strong hydrochloric acid. The calcium salt is then converted to the sodium or potassium salt by addition of the necessary amount of the corresponding carbonate, accurately weighed out. The precipitate of calcium carbonate should be agitated with the solution for an hour or more, then filtered, washed free from iodide and discarded. The solution of alkali iodide is then evaporated to crystallization or preferably to dryness. The salts so obtained are colorless and pure and quite as useful in the laboratory as similar salts purchased from dealers.

New Container for Foods. The American Can Company is reported in *The Business Week* as working with the Eastman Kodak Company in the development of an entirely new type of container for food products which may largely displace glass and metal.

The new material is said to be a cellulose compound discovered accidentally by the Eastman laboratories in experimental film work. Although the idea of a cellulose container is not new, this is reported to be the first discovery of a product strong enough to stand up under acids and wear. It is said to be nearly as strong as metal, as transparent as glass, and lighter in weight than either.—*Business Chem.*

THE ALKALI CARBONATE FUSION IN QUALITATIVE ANALYSIS

JACOB CORNOG AND HERSCHEL HOPSON, UNIVERSITY OF IOWA, IOWA CITY, IOWA

Historical

Historically, the use of alkali carbonates in metallurgical and ceramic processes is very old. Mineralogists were among the earlier ones to use the alkali carbonates in the laboratory for disintegrating minerals, in a way analogous to the present practice in making sodium carbonate fusions. From H. Rose,[1] it may be learned that in 1765 Marggraff used the alkali carbonate disintegration of minerals in the "dry way"; and that during the earlier part of the nineteenth century, workers who disintegrated minerals by alkali carbonates in the dry way were troubled by contamination of the sample through disintegration of the crucible. To avoid such contamination the refractory sample was disintegrated in the "wet way," that is, by repeated extraction of the sample with a water solution of the alkali carbonate. It may be inferred, though Rose does not so state, that disintegration in the dry way came to be preferred when platinum crucibles became available. H. Rose[2] studied the decomposition of barium sulfate by fusion with alkali carbonates from what now would be termed the viewpoint of mass action. He reports as follows:

1. That when barium sulfate and potassium carbonate were fused together in a 1:1 ratio, the barium sulfate was only partly decomposed, but that a 1:6 ratio of potassium carbonate or a 1:8 ratio of sodium carbonate caused complete decomposition of the barium sulfate.

2. That the addition of potassium sulfate to fused mixtures of potassium carbonate and barium sulfate hindered the decomposition of the barium sulfate. When the ratio of potassium sulfate to potassium carbonate was 3:1 or greater, no barium sulfate was decomposed by the fusion. Spring,[3] Parker,[4] and Tammen[5] found that partial decomposition ensued when mixtures of powered barium sulfate and alkali carbonate were subjected to great pressures at temperatures below the melting point of the mixed dry salts. Niggli[6] reports that a mixture of 46 mole per cent of potassium carbonate and 54 mole per cent of sodium carbonate, constitute a eutectic mixture having a melting point 712°. Since the melting point of sodium carbonate is 852°, and that of potassium carbonate is 891°, the eutectic mixture, because of its lower melting point, would seem a more convenient flux than either sodium carbonate or potassium carbonate alone. However, Scott[7] raises the objection that silicates are less

[1] *Pogg. Ann.*, **94,** 481 (1855).

[2] *Ibid.*, **95,** 96 (1855).

[3] *Bull. Soc. Chim.* (2) **44,** 166 (1885), and (2) **46,** 299 (1886).

[4] *J. Chem. Soc.*, **113,** 397 (1918).

[5] *Z. anorg. Chem.*, **149,** 21 (1925).

[6] *Ibid.*, **106,** 126 (1919).

[7] "Standard Methods of Chemical Analysis," 4th ed., D. Van Nostrand Co., New York City, p. 444.

apt to be disintegrated in a flux having a 712° melting point than in a flux having an 852° melting point, though he does not give any reason why the low-melting flux could not be heated to the higher temperature. In concluding this historical review, it may be noted that until recent times the gas flame was used to cause fusions and that temperatures were gaged by the incandescence of the crucible. Later workers used the more accurately controlled electrical heating devices.

Experimental

In the present report the following items relating to the alkali carbonate fusion have received experimental study, particularly with reference to their use in elementary qualitative analysis.

A. The crucible.
B. The quantity of flux.
C. Getting the fusion mixture to melt.
  I. The eutectic flux.
  II. The flower pot furnace.
D. Removing the melt from the crucible.

Apparatus and Materials.—An electrical resistance furnace was used for heating where closely regulated temperatures were employed. Temperatures were measured by a platinum, platinum-iridium thermocouple, and a millvoltmeter and are accurate to 3°. The reagents used were of the "analyzed" variety as obtained from commercial sources.

A. The Crucible. Typical fusions were made in crucibles of platinum, nickel, iron, and porcelain. The platinum and nickel crucibles had diameters of 4 cm. and depths of $4\frac{1}{2}$ cm. The iron crucibles were hemispherical, having a diameter of 4 cm. Barium sulfate was the refractory material used in the typical fusions. The flux used was the eutectic mixture of sodium carbonate and potassium carbonate described later in this publication. The quantity of flux used corresponded to six moles of the alkali carbonate to one mole of the barium sulfate. The fusions were made in unshielded crucibles with a Bunsen burner used as the source of heat. In each case the melt was digested in water, the water-insoluble portion was isolated by filtration, dissolved in 6 *M* hydrochloric acid, precipitated and weighed as barium sulfate. The recovery of barium sulfate is indicated in Table I.

TABLE I

BARIUM SULFATE RECOVERED AFTER FUSION

Using platinum crucible	99.75
Using nickel crucible	99.47
Using porcelain crucible	98.68
Using iron crucible	97.25

These data indicate that any one of these four kinds of crucibles may be used in qualitative analysis if, in each case, consideration is given to the kind of contamination that results.

The iron crucibles merit special mention. They were hemispheres of sheet iron costing less than one cent each. They were the so-called "domes of silence" which furniture dealers sometimes use to cap chair legs. During fusion these iron crucibles flaked badly. The flakes appeared later in the water-insoluble portion of the melt. These flakes are not appreciably dissolved by water or by 6 *M* hydrochloric acid and may be removed by filtration. These iron crucibles will not ordinarily withstand more than one fusion but their cheapness commends their use where iron contamination is permissible. Porcelain crucibles showed less disintegration than might have been expected, but because of the uncertainty of their composition the nature of the contamination they give is also uncertain. Where available, platinum crucibles are most satisfactory.

B. The Quantity of Flux and Other Factors. In these experiments barium sulfate was fused during 30 minutes at 850° with sodium carbonate. The quantity of flux used varied from one-half to four moles of sodium carbonate to one mole of barium sulfate. In each case the melt was analyzed for each of the four substances represented in the following equation.

$$BaSO_4 + Na_2CO_3 \longrightarrow BaCO_3 + Na_2SO_4 \qquad (1)$$

The data thus obtained warrant the following observations:

1. The percentage of barium sulfate decomposed increased progressively as the quantity of flux was increased. This relation is indicated in the following summary.

TABLE II

Initial molar ratio $BaSO_4$: Na_2CO_3	1:½	1:1	1:2	1:3	1:4
% $BaSO_4$ decomposed	16	35	78	92	99

2. Values computed for the equilibrium constant of the reaction represented by equation (1) vary widely when the initial ratios of barium sulfate and sodium carbonate are varied. This variation may be due to any one or all of the following causes; equilibrium might not have been reached during fusion, the reaction may be heterogeneous, an indeterminate shift in equilibrium might have occurred while soaking the melt.

3. When successive runs were made using the same initial ratio of barium sulfate to flux, discordant results were obtained when the duration of soaking was prolonged beyond 30 to 60 minutes. This tendency to reversibility during soaking decreases as the initial quantity of flux is increased.

In the present study no experiments were made to determine the influence exerted by the length of time the fusion mixture was in the molten

state. Parker[8] studied the rate of transformation of sodium carbonate when fused with barium sulfate and found that after the mixture had been in the fused state for three minutes no further change was noted up to thirty minutes. After the contents of the crucible have been completely melted for a few minutes there is little point in continuing the fusion for a long time unless the refractory material being reduced is in rather large pieces.

C. Getting the Fusion Mixture to Melt. When the fusion mixture does not melt after a few minutes heating, it follows that the melting point of the mixture is above the temperature of the heat applied. Since the melting point of sodium carbonate is 852° and that of potassium carbonate is 891° it may be supposed that a temperature of approximately 900° is suitable for use in alkali carbonate fusions as ordinarily conducted. With adequate gas pressure the necessary temperature may be obtained with special burners of the blast or Fisher type. But in many laboratories such burners are not available. In the following paragraphs two expedients are suggested to meet the difficulty.

1. The eutectic flux. The use of mixtures of sodium carbonate and potassium carbonate as a flux rather than either one alone is an old practice. As reported by Niggli[6] a mixture of 54 moles of sodium carbonate with 46 moles of potassium carbonate forms a eutectic having a melting point of 712°. As redetermined in the present study the eutectic mixture is composed of 59 moles of sodium carbonate to 41 moles of potassium carbonate with a melting point close to that reported by Niggli. Fusion mixtures using the eutectic flux are easily melted by the heat of a Bunsen burner. No shielding is necessary.

To put to the proof Scott's[7] objection, the eutectic flux was used in a number of fusions that were made in unshielded platinum crucibles that were heated for 30 minutes by an ordinary Bunsen burner. Samples of silica, barium sulfate, and granite, as representative refractory materials, were decomposed in this manner. After each fusion the residue not dissolved by water or by dilute hydrochloric acid was weighed. The weights of the original samples and of the residues are shown in Table III.

TABLE III

Material	Wt. of sample	Wt. of residue	Per cent of sample undecomposed
$BaSO_4$	0.8869 g.	0.0024 g.	0.27
$BaSO_4$	1.7565	0.0046	0.23
Granite	0.9849	0.0024	0.24
Granite	0.9524	0.0024	0.25
Silica	1.000	0.0000	0.00

These data indicate that the eutectic flux is suitable for routine fusions in qualitative analysis.

[8] *Loc. cit.*, p. 396.

II. The flower pot furnace. To make a flower pot furnace, enlarge, if necessary, the gas inlet at the bottom of a Bunsen burner till a flame ten or more inches high may be obtained. Also knock the bottoms from two clay assay crucibles. Clay flower pots will serve. Assemble the apparatus as indicated in Figure 1. It is essential that the opening into the lower clay crucible be at sufficient distance above the burner to allow an abundant supply of air to enter the combustion cavity with the flame. During the operation of the flower pot furnace, a slight roar suggestive of a gas muffle may be heard. The authors have had no difficulty in fusing sodium carbonate in this furnace.

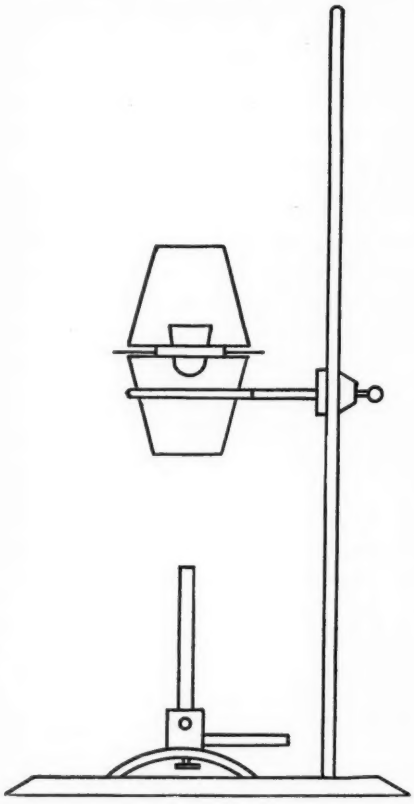


FIGURE 1

D. Removal of the Melt from the Crucible. Both economy of time and the undesirable effects of long soaking of the melt in water indicate the desirability of quickly removing the melt from the crucible. The following expedients, none of them new, have been tried.

If the crucible used is of platinum and is free from dents and deformities, the melt may ordinarily be removed by allowing the crucible to cool to room temperature and inverting the crucible. The melt, having the greater coefficient of contraction, will often crack completely loose from the crucible. The expedient of inserting a platinum wire in the liquid melt and later using it as a handle when the melt has solidified may be used. A variation of this practice is to heat the crucible enough to loosen the melt, then use the handle to lift the melt.

The removal of the melt is more difficult when the crucible is rough or deformed. If the crucible is tipped in an oblique position so that the mass solidifies in contact with only one side and part of the bottom of the

crucible, a few sharp raps usually suffice to dislodge the melt. If undesirable contamination does not occur, a very good method for handling the melt is to pour the hot liquid melt out on a cold slab, just as one would form a batter cake. Whenever the melt is removed from the crucible without water soaking, the solid cake should be pulverized before placing it in water. This is for the purpose of reducing the time of soaking. For routine use in qualitative analysis the practice of pouring the hot melt on a cold slab is commended.

In cases where it is impractical or undesirable to remove the melt by any other method than water soaking, the time necessary for soaking will be reduced if the surface of the solid melt in contact with the water is increased. Hence allowing the melt to solidify while the crucible is in an inclined position, or rolling the crucible just before the melt hardens so as to spread the melt over much of the interior surface of the crucible, or any other expedient that will increase the free surface of the melt when it congeals will lessen the time necessary for soaking.

Conclusions

The data described in the text of this paper support the following conclusions regarding the use of the alkali carbonate fusion in qualitative analysis.

1. Crucibles of platinum, nickel, iron, or porcelain may be used for making alkali carbonate fusions if heed is given to the kind of contamination that results in each case.

2. When barium sulfate and sodium carbonate are fused together the quantity of barium sulfate decomposed increases as the molar ratio of the flux used increases. When the ratio of four moles of sodium carbonate to one of barium sulfate is reached, the barium sulfate is completely decomposed. The decomposition reaction is somewhat reversible when the melt is soaked in water more than 30 to 60 minutes.

3. The composition and melting point of a eutectic mixture of sodium carbonate and potassium carbonate have been redetermined. The eutectic mixture is composed of 59 moles of sodium carbonate to 41 moles of potassium carbonate and has a melting point of 710° ± 1.5°.

4. The eutectic mixture has been found to be a satisfactory flux for decomposing silica, barium sulfate, and granite, at temperatures obtained by the use of a Bunsen burner.

5. The flower pot furnace has been described. By its use sodium carbonate may be fused without resort to the use of the blast or other special burners.

6. Methods for removing the melt from the crucible are described. The practice of pouring the hot liquid melt out of the crucible onto a cold slab is commended.

MINUTES OF THE MID-WINTER MEETING OF THE EXECUTIVE COMMITTEE OF THE DIVISION OF CHEMICAL EDUCATION OF THE A. C. S.

The meeting was called to order by the Chairman of the Division at 10.00 A.M., January 3rd, in the office of the Chemical Foundation, Incorporated, New York City.

Present: J. N. SWAN, *Chairman;* M. V. MCGILL, *Vice-Chairman;* R. A. BAKER, *Secretary;* ROSALIE M. PARR, *Treasurer;* WILHELM SEGERBLOM, *Past Chairman;* NEIL E. GORDON, *Editor-in-Chief;* and WM. W. BUFFUM, *Business Manager.*

Reports of Officers

1. Secretary's Report: The *Secretary* reported that through the generosity of the Chemical Foundation, Incorporated, he had been given the services of a full-time assistant. Since the Minneapolis meeting his office has been concerned chiefly with (*a*) correlating the work of the standing committees, (*b*) conducting a campaign for active and associate members, (*c*) renewing contacts with the Local Associations which have been granted representation in the Senate of Chemical Education, and (*d*) arranging the program for the Atlanta meeting next April.

Notices regarding membership and application blanks have been published in recent issues of both THIS JOURNAL and *The Chemistry Leaflet.* They have also been mailed to the secretaries of fifty-three Local Associations and to individuals whose names are on file. Up to December 31st a total of 104[1] had registered as active members, and 69 as associate members of the Division.

Applications are acknowledged promptly and a copy of the revised constitution is mailed each new member. Associate membership cards also are being prepared for distribution.

Of each $2.00 associate membership fee, $1.70 is designated as the subscription price of the JOURNAL OF CHEMICAL EDUCATION. To assist Local Associations in their work in the interest of chemical education, a rebate of 15% is allowed for each associate membership forwarded through the respective associations. The Business Manager of the JOURNAL grants an additional sum of seventy cents for each new subscription.

The *Secretary* outlined the plans for the Atlanta meeting. The suggested program was approved in form for announcement in the February issue of the JOURNAL OF CHEMICAL EDUCATION, pages 369–70, and in the January 20th *News Edition* of *Industrial and Engineering Chemistry.*

2. Treasurer's Report: The *Treasurer* presented the following report, which was accepted:

Receipts:	
Cash on hand, January 1, 1929	$ 63.01
Membership fees	89.00

[1] Totals on February first were 180 Active members and 261 Associates.

JOURNAL OF CHEMICAL EDUCATION	11.70
Chemical Foundation, Incorporated	1300.00
	$1463.71

Expenditures:

Expenditures incident to the meeting of the Executive Committee, 1/5/29	$ 220.06
Supplies and help in Secretary's Office	1209.14
Supplies and help in Treasurer's Office	6.50
Incidental Expenses, Minneapolis Meeting	25.00
Reprints JOURNAL OF CHEMICAL EDUCATION	24.13
Committee on Preparation of Teachers	4.00
Committee on Minimum Equipment	35.31
Committee on Professional Spirit	47.93
Committee on Order of Presentation	5.00
	$1577.07
Deficit	113.36
	$1463.71

3. Editor-in-Chief's Report: The *Editor-in-Chief* reported that all work in the editorial office is proceeding satisfactorily and recommended that changes suggested so far this year be deferred for consideration at the Atlanta meeting.

4. Business Manager's Report: Business Manager reported that there are now 11,500 subscribers to the JOURNAL OF CHEMICAL EDUCATION and 5300 subscribers to *The Chemistry Leaflet.* The latter was taken over by his office in October and its subscription list is growing very rapidly.

Every suggested method of bringing the JOURNAL to the attention of the high-school teacher has been tried, but the cost of maintaining a revised list is so great that the Division should seriously study the problem.

The financial statements for the JOURNAL and *Leaflet* will be published in a later issue of THIS JOURNAL.

Reports of Committees

1. Naming and Scope of Committees: WILHELM SEGERBLOM, *Chairman,* presented the following report, which was approved.

At the Minneapolis meeting "The question of revising the names of the Committees of the Division was referred to the *Committee on Naming and Scope of Committees.*" Since during the past year the Division through its various administrative agencies has thoroughly revised the list of committees of the Division and of the Senate, deleting inactive committees, combining certain other committees which seem to overlap in their activities, and revising the names of several of the committees in order to make the name of each more definitely indicative of its work, the list of the

Division's nine committees as published on page two of the November JOURNAL OF CHEMICAL EDUCATION, was submitted to our committee for approval and correction. Our committee has officially approved the name of the nine committees referred to above, *viz.:*

Research Problems
Women's Club Study Course in Chemistry
Aids to Visual Instruction in Chemistry
Minimum Equipment for High-School Chemistry
Naming and Scope of Committees
Professional Spirit among High-School Teachers
Preparation of High-School Chemistry Teachers
Order of Presentation of Recitation and Laboratory Work
Major Topic Organization of High-School Chemistry

The question of *Library Equipment*, or better, of *Chemistry Library*, was referred to our committee. The opinion is that this question is of sufficient importance to warrant a special committee to study it. A list of seven aspects of the question which such a committee might profitably look into brought out some interesting suggestions. As one member has not been heard from yet, the committee thinks it better to defer making its report to the chairman until the returns are complete.[2]

The question of *Chemical Education by Radio* was also referred to our committee, as a result of correspondence between Mr. Perry, Radio Counsel for the Committee on Education by Radio and the *Secretary* of the Division. Though this question opens up several possibilities the members of our committee are not so enthusiastic about this question as about the one on Chemistry Libraries. It is, therefore, even more desirable to have the opinion of the other member of our committee before making a final report. The appointment of such a committee will probably be recommended.

The committee feels that, since the *Secretary* of the Division has more divisional contacts than any other person concerned and is necessarily conversant with all the details of matters referred to us, it would be highly desirable and helpful to have him as a member of our committee. We, therefore, recommend that the *Executive Committee* instruct the *Chairman* of the Division to appoint the *Secretary* of the Division an *ex-officio* member of the *Committee on Naming and Scope of Committees.*

Following the adoption of this report the *Secretary* was appointed a member, *ex-officio*, of the *Committee on Naming and Scope of Committees.*

2. Aids to Visual Instruction in Chemistry: M. V. MCGILL, *Chairman*, presented the following report which was approved:

[2] Under date of January 17th, Mr. Segerblom wrote that all members have now been heard from and the report covering these two committees is being made to the Division Chairman.

The committee has corresponded by mail with practically all of the producers of visual educational material suitable for use in chemistry, particularly films, slides, and film-slides. A questionnaire was sent out in August with about a 60% response. A second questionnaire calling for specific data was sent out December 23rd to the companies which did not reply and to an additional list which we did not have in August. Replies are already coming in on these.

A tabulated list of exhibits from high schools and colleges at the Columbus meeting of the A. C. S. was published in THIS JOURNAL.[3] We feel that considerable progress has been made and we believe thoroughly adequate material is available. We have had fine coöperation from the various companies. There is a possibility of talking pictures being developed and a film library being formed at The Johns Hopkins University in connection with the Chair of Chemical Education.

The committee aims to get as much as possible of the available material on visual education before the teachers of chemistry. To this end a few articles will appear in THIS JOURNAL preliminary to the tabulated report which will appear in the September issue. It is the aim of the committee that this shall be very complete, concise, and up-to-the-minute. The committee realizes that all visual education does not have to do with slides and films and so will consider other phases which will include demonstration experiments, exhibit material which can be obtained from manufacturing companies, charts, etc.

We propose the following articles for the JOURNAL (1) *April issue:* A general article on visual education. This article will be written by Mr. Astell, reviewed by the committee, and published under the name of the committee as all our articles in the JOURNAL this year will be. (2) *May issue:* A one-page preliminary report of the committee to give a general idea of what is coming. (3) *June issue:* A paper on the mechanical side of visual education, which will be written by the members in Rochester and reviewed by the rest of the committee. (4) *July issue:* Special emphasis on the non-film and slide features of visual education with practical reference to exhibits at the American Chemical Society meetings. (5) *September issue:* A tabulation of the material on films, slides, etc. (6) *November issue:* Photographs of exhibits which have been worthwhile at both the Atlanta and the Cincinnati meetings of the A. C. S. with an appropriate write-up.

Starting next fall we propose to list regularly, in *The Chemistry Leaflet*, films, film-slides, and other visual material which is available on each subject, synchronizing as nearly as possible with the main topic in each issue.

As many films and slides as possible will be reviewed during the next six months with an idea of expressing in our tabulated report what per

[3] THIS JOURNAL, **6**, 1153–5 (June, 1929).

cent, for example, of each picture is suitable material to show a group of students in class time. The committee expects to promote a rather extensive exhibit of visual materials and school exhibits at the Cincinnati meeting. The committee realizes that the program set out for this year is only preliminary but one which is at the same time a foundation for very useful work which can be accomplished later.

The *Executive Committee* voted to approve the expenditure of $100 by this committee during 1930.

3. Professional Spirit among High-School Teachers: The following report was received by letter from L. W. MATTERN, *Chairman:*

Exchange of views by correspondence within our committee and personally with others in the United States Bureau of Education bearing on a report to the *Executive Committee* in regard to two proposed projects, was followed by the approval of these projects, and has led to correspondence with all the secretaries of the Local Sections of the American Chemical Society, and some 260 high-school teachers of chemistry scattered throughout the United States. Our committee will have reports covering the results of these two lines of correspondence for the Atlanta meeting, and it is believed that these reports will be of sufficient value in the cause of chemical education to warrant their publication.

During 1930 the committee plans to correspond with secretaries of local sections relative to technical programs for chemical education, with high-school teachers of chemistry in regard to certain phases of their replies to questionnaires, and with our committee in the exchange of views on our two proposed reports. It will be necessary to employ stenographic help in the preparation of these reports for the *Executive Committee* and the Senate of Chemical Education.

This report was approved.

4. Preparation of High-School Chemistry Teachers: A. J. CURRIER, *Chairman*, reported by letter as follows:

Two projects have been undertaken during 1929: *first*, a study of the curriculum requirements for secondary teachers of chemistry in the European countries (this topic was suggested by the *Secretary* of the Division earlier in the year); *second*, a questionnaire study of subjects taken by American chemistry teachers to be included in future curriculum requirements. This project is undertaken jointly by the *Committee on Professional Spirit among High-School Teachers*, of which PROFESSOR L. W. MATTERN is *Chairman*, and the *Committee on Training of High-School Chemistry Teachers*.

The committee has sent requests to some fifteen ministers of education in foreign countries, including the British possessions, for material bearing on curriculum requirements. These requests were sent out November 6, 1929. Replies have not been received as promptly as anticipated, but we

expect that we may have something worthwhile to report at the spring meeting.

Professor Mattern has not reported as to how many of his questionnaires have been returned. It is expected, however, that enough replies will be in hand to make at least a preliminary report at the spring meeting.

Professor Mattern obtained a considerable help in connection with the study of training requirements in foreign countries from DR. JAMES F. ABEL, Specialist in Foreign Education, United States Bureau of Education, Washington, D. C. The personnel of our committee has been decreased by one member but it seems that the three members can take care of the work at the present time. The committee would be very glad to receive suggestions for additional studies from any source.

This report was approved.

5. Women's Club Study Course in Chemistry: HARRISON HALE, *Chairman*, reported by letter as follows:

Arrangements have now been completed for the publication in full of the Club Study Course on American Chemistry, in the JOURNAL OF CHEMICAL EDUCATION for February.[4] Registration in this course will be made through the Bureau of Women's Clubs of the University of Arkansas, Fayetteville, and reprints will be furnished to women's clubs who decide to register in the course. Through the active coöperation of the Chemical Foundation, books will be provided for this study at a very low price. It is our hope to put an announcement of this course in the hands of every club secretary in the United States, so there will be some expense for clerical work and postage. At present it seems that this will be fully covered by the $1000 which the Chemical Foundation has already set aside for the work of the committee.

This will be the main work of the committee during the coming year, in which we ask all the cöoperation possible.

This report was approved.

6. Order of Presentation of Recitation and Laboratory Work: FRANK N. GREENLAW, *Chairman*, reported by letter as follows:

Dr. Parr's investigation in Illinois was reported at the Minneapolis session and will be published in detail in THIS JOURNAL.[5]

While it seemed inadvisable to repeat the work which she did so well, a somewhat similar experiment has been carried out in the Rogers High School, Newport, Rhode Island, utilizing material which I had intended for a wider testing. The more limited scope of the experiment, including 110 individuals, will perhaps be compensated for by the more rigid control and exclusion of variables. I shall hope to have a summary of this work ready for the Atlanta meeting.

[4] THIS JOURNAL, **7**, 325–40 (1930).

[5] See this issue, pages 571–86.

I believe that the work of this committee presents some rather definite evidence that, judging solely from the standpoint of range of information and retention of learning, recitation first produces higher scores. Whether it will be possible to devise tests for other values which have been claimed for laboratory methods I am as yet uncertain.

The matter of lecture-demonstration versus laboratory instruction is not conclusively established, in spite of a number of investigations, and this matter has more vital bearing upon the whole question of high-school teaching of chemistry than has the order of presentation. The work of the committee might well be continued along these lines.

This report was approved.

7. Labels: JOHN M. MICHENER, *Chairman*, presented the following report by letter:

We have written to all the laboratory supply houses in regard to their attitude toward the present label books on the market, also toward a proposal to put out a new one, if that should seem necessary in the future. Most of the houses are much dissatisfied with the label books on the market and would be glad to coöperate in putting out a new book.

The committee expects to (*a*) make a survey of representative high-school and college instructors to see what labels should be represented in a label book, (*b*) try to get the publisher of the now most widely used label book to revise it in his next publication which occurs soon, and (*c*) make public, through THIS JOURNAL, some interesting information concerning some of the label books now on the market, also requesting opinions concerning the work.

Miscellaneous Business

1. Voted to approve the application of the Wichita Section of the A. C. S. for representation in the Senate of Chemical Education and upon the Board of Contributing Editors.
2. In view of the fact that there are at present no Local Sections of the A. C. S., and no Science Teachers Association in the state of Mississippi, it was voted to appoint the following to the Senate of Chemical Education representing that state:

   College Representative, DR. A. E. WOOD, Mississippi College, Clinton.
   High-School Representative, MR. C. O. HINTON, Perkinston, Miss.
   Industrial Representative, MR. CHARLES A. LAMBERT, Hercules Powder Company, Hattiesburg.

3. The *Secretary* was instructed to invite each of the Local Sections in the state of Tennessee to function in the interests of chemical education in their respective areas.
4. With reference to the JOURNAL OF CHEMICAL EDUCATION, it was voted to substitute for the line "A Monthly Journal Devoted to the In-

terests of Chemistry Teachers" the following, "Official Organ of the Division of Chemical Education of the American Chemical Society."

5. The Mack Printing Company has been holding plates for a number of articles which have appeared in THIS JOURNAL with a view to reprinting under one cover these articles and others, which were to have been collected by the *Committee on Research Problems of High-School Chemistry Instruction*. At the Minneapolis meeting it was voted to discontinue the above committee and to refer such questions as may arise to the *Committee on Naming and Scope of Committees*. The *Executive Committee* voted to instruct the Mack Printing Company to knock down the type now being held, and to refer to the *Committee on Naming and Scope of Committees* the question of abstracting or collecting these articles.
6. Voted to refer to the *Committee on Naming and Scope of Committees* the question of establishing a *Committee on Teacher Exchange*.
7. Voted that the lists of the Division officers, committees, and members of the Senate appear immediately after the Table of Contents and before the frontispiece in the JOURNAL, the pages to be unnumbered.
8. Voted that each committee send advance copies of all questionnaires and general communications to the *Secretary* to prevent overlapping.
9. It was the opinion of the *Executive Committee* that only a limited number of projects be recommended for nation-wide study in any one year.

   The *Secretary* was instructed to circularize the Senate, calling attention to this recommendation and requesting an expression of opinion as to which committee project should be favored at this time.
10. The *Secretary* was instructed to send to members of the Senate copies of the Minutes of the Division.
11. The estimate of expenses for the current year was discussed and approved.
12. Miss Parr was appointed a committee to express our appreciation of the interest and assistance of the Chemical Foundation, Incorporated. She presented the following resolution which was adopted unanimously:

The Executive Committee of the Division of Chemical Education of the American Chemical Society extends to the Chemical Foundation, Incorporated, most sincere thanks for the continued interest and help given to further the work of the Division during the past year especially in relation to financing the JOURNAL OF CHEMICAL EDUCATION, *and a number of projects being developed under the direction of the Division of Chemical Education.*

To MR. AND MRS. GARVAN, *the Committee extends greetings and an expression of most earnest appreciation for their personal interest and their broad*

influence not merely in the work of this Division but in the relation of chemical education to the betterment of society throughout the world.

Adjourned at 12.00 M., having been in session as follows: Friday, January third, 10.00 A.M. to 12.30 P.M., and 1.30 P.M. to 5.30 P.M.; Saturday, January fourth, 9.30 A.M. to 12.30 P.M.

R. A. BAKER, *Secretary*

Question of Ether Again Confronts Scientists. Professor Dayton C. Miller has reported to the Optical Society of America meeting at Ithaca, New York, that he has during the past year laboriously repeated the ether drift experiments that he has been making during the last nine years in a Cleveland laboratory and on high Mount Wilson in California. Again he finds an observed effect in the light path of his apparatus such as would be produced by a relative motion of the earth and the ether of about ten kilometers (six miles) per second. This is the same result that Dr. Miller has obtained during the past few years. In 1925 his paper on this work won the annual prize of the American Association for the Advancement of Science. This continued ability to obtain the same results over a period of years, whether the apparatus is at normal level in Cleveland or on a California mountain, makes Dr. Miller's results all the more important.

Nor does Dr. Miller feel that his experiments repudiate the famous Michelson-Morley experiments on ether drift performed in 1887. Prevalent opinion holds that this historic test showed that there is no ether drift, that there is no something filling all space, and it was upon this interpretation that Prof. Albert Einstein based his special theory of relativity when he enunciated it in 1905. But Dr. Miller, studying the results of his latest experiments performed this year on the campus of the Case School of Applied Science, only about 300 feet from the location of the original Michelson-Morley interferometer of 1887, finds that his results showing the solar system moving through space "fully agree with and confirm the original Michelson-Morley observations, although the present interpretation is different."

In the 1887 Michelson-Morley experiment there was discovered a slight difference in the time that it took light to travel over two paths, one at right angles to the other. But this was attributed to experimental errors, to those slight deviations that enter into all observations. Dr. Miller, by performing hundreds of experiments and by improving the details of the ether-drift interferometer, has by his results demonstrated that the observational differences of the original experiments and his many later tests are real and not due to error in the apparatus. Such refinements as shock-absorbing pads on the supporting piers and extreme precautions to eliminate temperature differences were taken in this year's experiments. The interferometer uses the interference of light waves to measure far more accurately than any mechanical means. Dr. Miller's instrument gives numerical results reliable to the hundredth part of a wave-length of light, although the length of the light path is 130,000,000 wave-lengths. He can detect a relative motion of earth and ether a twentieth that which he actually observed.

The discovered motion of six miles a second is not a mere earthly phenomenon, but a cosmic one. It is fixed with relation to sidereal time, that is, it is toward a fixed place in space. The earth and its millions and the whole solar system is rushing, Dr. Miller declares, "toward the point having a right ascension of 17 hours."

How are the scientists to reconcile with their theories this well-tested motion that the ether-drift experiments demonstrate? Dr. Miller says: "It seems impossible at the present time to account for a cosmic effect of this small magnitude and it will be necessary to continue these experiments and to coördinate them with others before an acceptable theory can be propounded."—*Science Service*

The Chemistry Student

THE THEORY OF TYPES—A SATIRICAL SKETCH

HAROLD B. FRIEDMAN, GEORGIA SCHOOL OF TECHNOLOGY, ATLANTA, GEORGIA

Satire has ever been one of the most powerful weapons of literary warfare, which fact Bulwer-Lytton no doubt had in mind when he caused Richelieu to say that "The pen is mightier than the sword." Before presenting the following bit of satire relating to chemistry, it is well to recall the incidents which led up to it.

In the historical development of chemical theories one finds the period 1830–40 characterized by the bitter contention of adherents to rival theories of molecular structure. Berzelius and his dualistic ideas were slowly giving way to the formulation of the radical theories of Liebig and Wöhler, and the first theory of types by Dumas. The year 1828, it may be recalled, marked the overthrow of the sharp boundary between organic and inorganic chemistry, as the result of Wöhler's synthesis, from ammonium cyanate, of urea, formerly obtained only from vital processes. Other syntheses soon followed, all of which made unnecessary the existence of a "vital force."

When the conservative Berzelius realized that the fundamental laws of combination of inorganic chemistry applied to organic compounds as well, he set out to explain the phenomena at hand with a dualistic electrochemical theory. Reluctant to remove oxygen from the important place that it occupied in his older theories, he assumed that the "base" or "radical" with which it was combined in inorganic compounds was simple, while in organic compounds a complex radical.

In 1832, the concept of "radical" took on a more serious significance with the publication by Liebig and Wöhler of their classical work, "Researches on the Radical of Benzoic Acid."[1] In these researches they showed the persistence, throughout a series of reactions, of the group $C_{14}H_{10}O_2$, which they called *benzoyl*. For example, benzaldehyde was $C_{14}H_{10}O_2 \cdot H_2$; benzoic acid, $C_{14}H_{10}O_2 \cdot O \cdot H_2O$; benzoyl chloride, $C_{14}H_{10}O_2 \cdot Cl_2$, and so on.

Shortly after this, Dumas made a remarkable discovery.[2] He found

[1] *Annalen der Chemie*, **3**, 249 (1832).

[2] One evening, at a *soirée* at the Tuileries, during the reign of Charles X, the pleasure of the entertainment was seriously marred by the fact that the wax candles emitted very unpleasant, irritating fumes, and were remarkable for the smokiness of their flames. The investigation of the cause of their peculiar behavior was entrusted to Dumas. The irritating fumes were found to be hydrochloric acid, and Dumas had no difficulty in discovering that they were due to the candles having been made from wax which had been bleached by chlorine. He soon found that, when chlorine acts on compounds

that in such a compound as CH_4, the hydrogens might be successively replaced by other elements, such as chlorine, quite different from hydrogen, yet at each stage of the substitution producing a compound not markedly different from the preceding one. This phenomenon he found to be very widespread and general, and to account for it he devised his Theory of Types. In this he likened the elements of a compound to a solar system, a sun with its accompanying planets, the units of which were held together by the forces of mutual attraction. If a unit of such a system be replaced by another, even of a different nature, the result would be not unlike the original, just as if a planet of our solar system were substituted by another, the properties of the mechanical system would remain approximately the same as before. In other words, the properties of a molecule depended more upon the number and relative positions of its component atoms than upon their nature.

Instances of substitution increased rapidly, and the theory became very popular. Dumas, however, in his enthusiasm for it, applied the theory to every imaginable reaction, even seeing substitution in many cases where the analogy was very far-fetched. He admitted substitution, not only of hydrogen, but also of oxygen, and even of carbon, by elements or groups. His efforts at application went to such extremes that they soon brought forth the ridicule of the more thoughtful and conservative-minded, who, willing to admit the truth of the basic idea, would not go to the limits Dumas would take them in making his theory general.

It is one of these attempts at ridicule that is presented here, as a very interesting oddity which appeared in a journal of the time.[3] It is a letter, written by one S. C. H. Windler, to Liebig, editor of the *Annalen*, begging him to announce in his journal "one of the most brilliant facts of organic chemistry." He proceeds to outline the details of a spurious piece of research, in which starting with manganese acetate, by passing in chlorine, he successively replaces the hydrogen, the oxygen, the carbon, and finally even the manganese, ending up with a compound of pure chlorine, but preserving the original type! The *s(ch)windler* was Wöhler—and there is a footnote, added presumably by Liebig himself in which he says that some of this new substance, of nothing but chlorine, has been spun into cloth and is already quite popular in the shops and hospitals of London.

---

containing hydrogen, the hydrogen may be removed and replaced by an equivalent quantity of chlorine. This observation was not, it is true, a new one; Gay-Lussac, Faraday, and Liebig and Wöhler had all observed that hydrochloric acid is emitted, and chlorine fixed by organic bodies. But Dumas first systematically examined this kind of action, laid down the rules which it follows, and, jointly with Laurent, who first perceived their significance, developed their consequences.—"Justus von Liebig, His Life and Work," by Shenstone (Macmillan).

[3] *Annalen der Chemie*, **33**, 308 (1840).

and is preferred to all others for nightcaps, drawers, etc.! The letter, although in the German journal, is in French, and its translation follows.

On the Substitution Law and the Theory of Types

Written Communication to J. L.

Paris, March 1, 1840

Sir:

I hasten to communicate to you one of the most striking facts of organic chemistry. I have verified the theory of substitution in an extremely remarkable and perfectly unexpected manner. It is only from the present that one will be able to appreciate the high value of this ingenious theory, and that one will be able to foresee the immense discoveries that it promises to realize for us. The discovery of chloracetic acid and the constancy of the types in compounds containing chlorine, derivatives of ether and ethyl chloride, have led me to experiences which I am now going to describe. I passed a stream of chlorine through a solution of manganese acetate, under the direct influence of sunlight. After 24 hours I found in the liquid a superb crystallization of a violet-yellow colored salt. The solution contained only the salt itself and some hydrochloric acid. I analyzed the salt: it was manganous chloracetate. Thus far nothing extraordinary, simple substitution of the hydrogen of the acetic acid by a like number of equivalents of chlorine, already known through the beautiful researches on chloracetic acid. This salt when heated at 110° in a stream of dry chlorine was converted with liberation of oxygen gas into a new golden yellow compound, whose analysis led for its composition to the formula $MnCl_2 + C_4Cl_6O_3$. There was then, substitution of the oxygen of the base by chlorine, what one has observed in a great number of cases. The new substance was dissolved in very pure chloral with the aid of heat, and I used this liquid, stable with chlorine, to continue the treatment with this agent. I passed dry chlorine into it for 4 days, keeping the liquid always very near its boiling point. During this time there was constantly deposited a white substance, which in a careful examination was recognized as manganous chloride. I cooled the liquid some time after, when there was no more of the precipitate and obtained a third substance in small greenish-yellow silky needles. This was $C_4Cl_{10}O_3$, or in other words was the acetate of manganese in which all of the hydrogen and the oxide of manganese had been replaced by chlorine. Its formula ought to be written $Cl_2Cl_2 + C_4Cl_6O_3$. There were therefore 6 atoms of chlorine in the acid, the four other atoms represented the oxide of manganese. As hydrogen, manganese, and oxygen can be replaced by chlorine, one will see nothing surprising in this substitution.

But this was not yet the end of this remarkable series of substitutions. In causing chlorine to act anew on a solution of this substance in water, there was a liberation of carbonic acid, and on cooling the liquid to +2° there was deposited a yellowish mass formed of little leaflets, closely resembling the hydrate of chlorine. Also it contained only chlorine and water. But in taking the density of its vapor I found that it was formed of 24 atoms of chlorine and one part of water. Behold then the most perfect substitution of all the elements of manganese acetate. The formula of the substance would be expressed by $Cl_2Cl_2 + Cl_8Cl_6Cl_6 + aq$. Although I know that in the decolorizing action of chlorine there is a replacement of hydrogen by chlorine and that the cloths which are now bleached in England preserve their types according to the laws of substitution, I believe nevertheless that the substitution of carbon by chlorine, atom for atom, is a discovery which belongs to me.—Be willing to take note in your journal and accept, etc.

S. C. H. Windler

The footnote is as follows:

I have just learned that there are already in the shops in London fabrics of spun chlorine, quite sought after in hospitals and preferred to all others for night caps, drawers, etc.

Nevertheless, in spite of these efforts at ridicule, it was realized that there was something fundamentally reliable in the conceptions of the Theory of Types. And while its opponents never accepted it bodily, they adopted the idea and merged it with the radical theory of their own, from which it was possible for Gerhardt to develop a second Type Theory. With this he was able to coördinate all the phenomena known at that time, to discover many new compounds, and in some cases to predict their properties.

THE GAME OF CHEMISTS

ESTHER ELKING,* JULIENNE HIGH SCHOOL, DAYTON, OHIO

Nothing is more enjoyable than membership in an interesting club. To be interesting a club must have a stimulating factor and some activity at each meeting to keep enthusiasm alive. This is one of the things that has made our chemistry club successful from the very beginning. Among our activities is the playing of games concerning chemistry, one of which is called, "The Game of Chemists."

The Game of Chemists is on the order of the well-known Game of Authors. Aside from being enjoyable it also helps to fix facts in our minds. We take a deck of cards and divide them into thirteen sets of four cards each. Each set concerns one chemist. On the first card is his name, nationality, and date of birth; on the second, one of his most famous experiments; on the third, the resulting discovery or law; and on the last, the date of his death.

This is an example of one of the sets. On the first card is the name, Joseph Louis Gay-Lussac, a French chemist, born 1778; on the second, his experiment on combining volumes of gas; on the third, volumes of gases used and produced in a chemical change may be represented in ratio of small whole numbers, and the fourth, died 1850.

The players draw cards from one another and when they have a complete set they lay them face up on the table. The game ends when one of the players is entirely out of cards, having disposed of them in the aforesaid manner.

This game is a very appropriate number on the program of a chemistry club meeting. For every four members there must be a deck of cards arranged in the same way.

* Winner of $5.00 award in undergraduate contest closing November 15, 1929.

CARBON DIOXIDE. III. ITS COMMERCIAL MANUFACTURE

ELTON L. QUINN, UNIVERSITY OF UTAH, SALT LAKE CITY, UTAH

From a commercial standpoint, the manufacture of carbon dioxide on a large scale offers few difficulties. Standard methods of production have been developed to such a high degree and the perfection of standard machines for carrying these reactions out has progressed to such an extent that almost any amount of this compound can be produced, in gaseous, liquid, or solid form. It would seem that the life of the carbon dioxide manufacturer would be a simple and easy one but such is not always the case. By far the largest amount of this substance is sold in the liquid form and containers capable of holding it are expensive and require a great deal of attention in inspecting, washing, repairing valves, painting, and testing. Shipping in tank cars has never been popular in this country, although in Germany Dr. Raydt has used railroad cars fitted with heavy steel cylinders for transporting carbon dioxide. In the United States, the liquid is practically always forced into standard cylinders of the 20- or 50-pound type.

Few commercial substances are put on the market in such a high degree of purity as carbon dioxide. The reason for this condition is due, perhaps, to the demand of the trade and the clean-cut and easily controlled processes by which carbon dioxide is made. Probably ninety per cent of the liquid carbon dioxide made in this country is used by the soda water industry for carbonating water, and for this purpose only gas of the highest purity can be used. The tolerance for gaseous impurities such as oxygen or nitrogen is not higher than 0.5% and odorous impurities must be entirely absent. Water is practically always present in commercial carbon dioxide in various amounts. Some manufacturers make an attempt to remove it, while others consider it of no importance and do not. Oil is often found in the bottom of the cylinders in which carbon dioxide is sold but if this is of a high grade and has no odor it does no harm as the carbon dioxide readily distils off in the pure condition, leaving the oil and most of the water behind.

Next to a gas with a bad odor, the bottlers of carbonated beverages object most to the presence of appreciable quantities of air. Such gaseous impurities produce a gas which is called "wild" and water carbonated with it fails to hold the carbon dioxide in solution, after the pressure is released. The resulting violent effervescence, when the bottle of soda water is opened, quickly depletes the solution of gas, leaving a flat and unpalatable drink. It is very likely that this effervescence is started by the bubbles of the foreign gas which serve to destroy the condition of super-saturation. Most carbon dioxide found on the market today will analyze as high as 99.8% pure.

The usual methods of manufacturing carbon dioxide fall into three

general processes. One of these makes use of the natural carbon dioxide found in nature, another uses the by-product gas obtained from the fermentation industry while the third may be considered the absorption process, although this process is used on gas obtained from several different sources. These methods of manufacturing carbon dioxide will be considered in this order.

Natural Carbon Dioxide

Occurrence.—While carbon dioxide escapes from the earth in numerous places, comparatively few of them supply a gas of high enough purity to be of commercial importance. Natural carbon dioxide is often contaminated with air and hydrogen sulfide besides traces of other gases. It is not a difficult task to remove these impurities, but for very satisfactory results, the absorption process must be used and this involves an expenditure which is not justified unless the gas well is close to the market, and this is usually not the case. Germany is perhaps better supplied with high-grade natural carbon dioxide than any other country, although France has several important wells. Some of the famous German springs are: Wiesbaden, Schwalbach, Selters, Homburg, Soden, Schlangenbad, Ems, and Nauheim. France possesses a number of such springs in the Auvergne and in the midst of the Vivarais. In the United States, the Saratoga Springs in New York and the Manitou Springs in Colorado, furnish a gas of some commercial importance. Little use is made of natural carbon dioxide in this country because without some artificial method of treatment, there is no way of controlling the purity or uniformity of the product, and the advantage of having the plant located close to the market, in practically all cases, greatly outweighs any gain in having the gas already formed.

Methods of Collecting.—In most places where natural carbon dioxide is utilized it comes to the surface of the earth accompanied by large amounts of water. When the pressure which holds the carbon dioxide in solution is decreased, as the water escapes from the earth, the gas effervesces and much of it escapes from the solution. The usual procedure is to place an iron cap or bell over the stream and by means of baffle plates permit the gas to issue from the top of the cap while the water flows out from under the bottom edge. Sometimes these iron covers have to be made exceptionally strong as there are cases on record where they have been split by the force of the stream.

At Saratoga Springs, the naturally carbonated water comes from the wells under a pressure of 21 pounds per square inch. Some years ago the gas and water from these springs were separated and the gas liquefied, but at the present time this is not being done.

By-Product Carbon Dioxide from Fermentation

The fermentation industry is of great importance as a source of industrial carbon dioxide. The vast quantity of this gas, which has been poured into the atmosphere for centuries, constitutes such a huge industrial waste that its utilization deserves and has received serious consideration. Until rather recently, most of the attempts to turn this waste product to practical account have been fruitless. The carbonated beverage industry, which uses by far the largest amount of carbon dioxide, objected to it on account of the odor which it nearly always carried with it. This odor, while not harmful in itself, gave the beverages to which it was added the aroma of fermenting mash and a much worse characteristic was the occasional carrying over of yeast cells that started fermentation in the finished product. The odors were mostly caused by aldehydes and higher alcohols produced during the process of fermentation and these could not be removed by the simple processes then used. The early manufacturers, in attempting to put this by-product gas on the market, failed to realize the importance of careful purification, with the inevitable consequence that fermentation carbon dioxide fell into disrepute, a condition from which it has not yet entirely recovered.

Recently, several methods of purifying fermentation carbon dioxide have been developed to a high degree of perfection and these purification processes are said to produce a gas which compares favorably with any other method of manufacture. It is very necessary, however, to adhere rigorously to a systematic inspection and cleaning of cylinders, to periodic analysis of the product and close supervision of the details of the process.

The Process of Fermentation.—In this country, the legitimate fermentation industries are confined almost entirely to industrial alcohol distilleries. While these plants may operate on almost any substance high in sugar, the majority of them use molasses as a raw product. For each gallon of alcohol produced by the fermentation of sugar, there is also formed about 6.6 pounds of carbon dioxide. The fermenters in which this reaction takes place are large wooden tanks or vats holding as much as 125,000 gallons of mash. Some of these are built with permanent covers provided with large openings for cleaning purposes; others are fitted with removable copper covers which are made gas-tight by means of a water seal. In either case the carbon dioxide is taken from the top of the fermenter by means of a pipe which conducts it to the purifying apparatus. As the process of fermentation is intermittent and the gas is collected only during the period of most active fermentation, a gasometer for storage is nearly always necessary. From the gasometer, the gas goes through the purifying system, after which it goes to the compressors.

The Backhaus Process of Purification.—This process, as it is conducted at the Curtis Bay, Maryland, plant of the United States Industrial Alcohol Company, uses the carbon dioxide from 15 fermenters, each with a capacity of 125,000 gallons of mash. The gas is first thoroughly washed with water in a Feld scrubber which removes a very large part of the aldehydes, alcohols, and other odorous organic compounds. The carbon dioxide still retains enough impurities, however, to make it quite unsuited for the uses to which it is generally put. The final purification is brought about by adsorbing these foreign gases on activated charcoal.

The purifiers in which the adsorption process takes place are cylindrical vessels about 13 feet high and 3.5 feet in diameter. Each of these is fitted inside with a coil of pipe, which serves as a heater or a cooler according to whether steam or cold water is circulated through it. The activated carbon is packed into this cylinder and while steam raises the temperature of the contents, dry carbon dioxide is passed through to remove any moisture from the charcoal. After cooling, two purifiers are connected in series and with cold water circulating through the cooling coils, they are cut into the purification system. The most efficient operation takes place when the temperature is kept below 110 to 120°F. and as the heat of adsorption tends to raise the temperature, cooling becomes of great importance.

When the carbon in a purifier has adsorbed considerable amounts of impurities from the carbon dioxide, it is cut out of the process and the adsorbent is subjected to a revivification treatment. During this treatment, high pressure steam, circulating through the coils, heats the mass, while low pressure steam passing through the charcoal, removes the adsorbed material. After the steaming process, the carbon is dried by passing a stream of warm dry air through, while the high pressure steam in the coils continues to heat it. Then the contents are cooled by substituting cold water for the steam in the coils, and the purifier is ready to enter the process again.

It is said that gas treated in this manner is of a very high quality and compares favorably with any on the market. The low water content, which is less than 0.1% by weight, makes further drying unnecessary, which is of considerable advantage as the gas can then go directly to the compressors.

The Reich Process of Purification.—This method of treatment makes use of reactions that are more distinctly chemical than those used in the Backhaus adsorption process. The organic impurities responsible for the disagreeable odor and taste are oxidized by chemical means and the products of the reaction are absorbed by scrubbing with the proper liquids.

The carbon dioxide taken from the top of the closed fermenters is first bubbled through a dilute alcohol solution in a wash box called a catch-all.

THE SMALL TOWERS ARE PART OF THE PURIFICATION SYSTEM OF THE REICH PROCESS FOR TREATING BY-PRODUCT FERMENTATION CARBON DIOXIDE. THE HIGH STEEL TOWER IS A COKE TOWER OF AN ADSORPTION SYSTEM WHICH WAS REPLACED BY THE REICH PROCESS

This serves to remove the entrained mash, some of the alcohols, esters, and aldehydes and to maintain a pressure on the fermentation vat.

After passing through the catch-all, the gas is washed in a scrubbing tower with dilute alcohol, the object of which is to remove the bulk of the higher alcohols, esters, etc., and then successively in two other towers with water. The scrubbers are packed with *spiral-ring fillers* over which the washing fluid is circulated with centrifugal pumps. The dilute alcohol from the first scrubber goes back to the alcohol plant where the alcohol is recovered.

The carbon dioxide, after washing, goes to a gasometer from which it is delivered continuously to the rest of the purifying system. It still

contains moisture, ammonia, sulfur compounds (depending upon the raw material fermented), and the odor of fermented mash. From the gasometer it is forced into the oxidizing tank, in which it is treated with a solution of potassium dichromate and then washed with sulfuric acid in a cast-iron washing tower. The successive treatment of the gas with dichromate solution and acid serves to destroy completely any remaining traces of organic impurities.

After the acid treatment, the gas passes up through a tower filled with soda ash, for the removal of small amounts of entrained sulfuric acid. The dried, acid-free gas is then finally treated with compressor oil, for the removal of the oxidation products, and is delivered to the compressor under a pressure of 2 to 3 pounds.

With such elaborate treatment it would seem that the purified carbon dioxide could hardly carry over any undesirable material from the fermentation vat. There is danger, however, during the scrubbing process, of contaminating the carbon dioxide with air. This is especially true when raw water, already saturated with air, is used for washing. A very ingenious method of eliminating this difficulty is in use at some by-product carbon dioxide plants. The liquid carbon dioxide from the compressor is run into a specially designed cylinder about the size of a standard 50-pound container. A tube extending nearly to the bottom of the cylinder withdraws the pure liquid for the filling station, while any air, not soluble in this liquid, rises to the top and mixes with the gas above the liquid. A bleeder pipe, connected to the top of the cylinder, continuously removes this gas mixture consisting of nearly pure carbon dioxide, and sends it back to the scrubbing system where it is used for treating the raw water to eliminate the air before it is used for washing purposes.

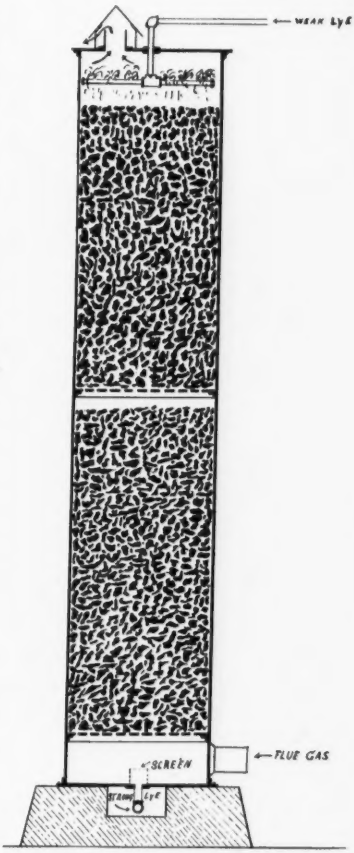
The Absorption Process

The general principles underlying the absorption process are very much the same, regardless of the source of the carbon dioxide or the method of applying. It consists of treating a gas containing carbon dioxide with a solution of potassium or sodium carbonate, resulting in part of the carbon dioxide reacting with the carbonate to produce a bicarbonate. Then this solution containing large amounts of bicarbonate is boiled, whereby the reaction is reversed and the carbon dioxide is liberated again in the pure condition. The equation for the reaction explains better than words just what happens.

$$K_2CO_3 + H_2O + CO_2 \underset{\text{about } 30^\circ}{\overset{\text{about } 100^\circ}{\rightleftharpoons}} 2KHCO_3$$

The Process of Absorption.—This method of absorption is usually applied to gases containing 15 to 18% carbon dioxide, such as flue gas

from burning coke; or exhaust gas from an internal combustion engine; or gases from lime kilns or burning magnesite which may run as high as 40% carbon dioxide; or occasionally to a gas nearly 100% pure from gas wells or fermentation reactions. The absorption takes place in all cases in towers from 50 to 100 feet high and from 6 to 10 feet in diameter. These towers are filled with coke over which is pumped the carbonate solution while the gas runs counter-current to it. The large surface afforded by the coke and the violent agitation of the lye solution as it tumbles down through the tower offer excellent conditions for the reaction between the lye and the carbon dioxide. It would seem that the lower the temperature the better the absorption, but this is not the case. The question of heat economy and the speed of the reaction makes a moderate temperature the most efficient and such absorption processes are usually conducted at the optimum temperature of about 30°C. This is so vital to the successful operation of a plant that an elaborate cooling system is used to keep the lye at this temperature.



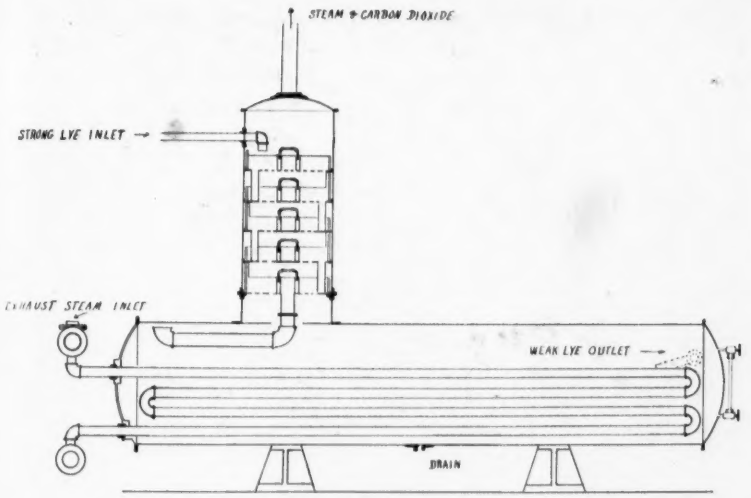
COKE TOWER OR ABSORBER FOR A CARBON DIOXIDE PLANT

In some plants the time of contact between the gas and absorbing solution is increased by the use of two coke towers, connected in series, and so arranged that the lye from the bottom of the second tower is pumped to the top of the first. In ordinary practice the concentration of the carbon dioxide is decreased to about 9 or 10% by volume of the flue gas. To get a lower concentration and thereby a higher absorption efficiency is not usually considered economical. Multiplication of coke towers will not increase the yield of the carbon dioxide sufficiently to pay for their installation and operation. In one system, absorption takes place under pressure, but this method is not in use in this country.

While many data on equilibrium, rates of reaction, temperatures, and speed of absorption have already been obtained, it cannot be said that coke tower design is as yet an exact science. Usually the capacity of such towers is based on the observed behavior of towers already in use, and it may be said that many other factors besides the size affect the efficiency of the absorbing unit. With the balance of the plant properly designed, two coke towers, each 10 feet in diameter by 100 feet high, operating on a high-grade flue gas, will absorb about 1000 pounds of carbon dioxide per hour.

The Lye Boiler.—The second unit of great importance in a carbon dioxide plant is the lye boiler, because here the reaction taking place in the coke tower is reversed, thereby regenerating the potassium carbonate which goes to the coke tower for more carbon dioxide. There are many forms and designs of lye boilers in use, but in general they are much like steam boilers of the vertical or horizontal type. In fact, an ordinary steam boiler serves the purpose very well in some cases. The heating tubes may be closed coils inside of the boiler through which exhaust steam from the engines and pumps is circulated, or they may be simply fire-tubes in a boiler arranged over a coke furnace which also supplies the flue gas for the coke tower. Most lye boilers are fitted with a high dome, filled with coke, rock, or special cast-iron plates. The object of this tower or analyzer is much the same as a heat-exchanger and serves to preheat the incoming lye with the consequent condensation of steam from the boiler. The carbon dioxide coming off from the lye boiler with some steam goes to a condenser, located above the boiler, from which the condensed water is returned to the weak lye tank, and the pure carbon dioxide to a gasometer. The boiled lye escapes from the boiler, is run through a heat-exchanger and back into the weak lye tank. The strong lye, that is, the solution containing the largest amount of bicarbonate, goes up through the heat-exchanger to the lye boiler, which it enters at a temperature not far from the boiling point.

A CARBONDALE LYE BOILER WITH A CAPACITY OF 100 POUNDS OF CARBON DIOXIDE PER HOUR

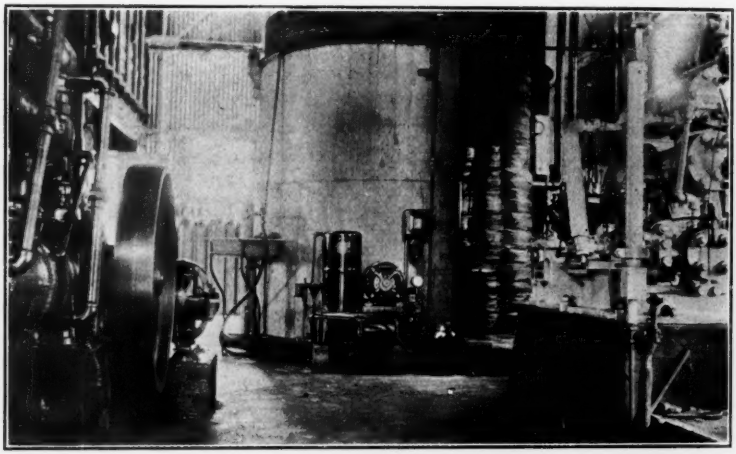


CARBONDALE LYE BOILER

The Purification of the Flue Gas.—When carbon dioxide is made by the combustion of coke, only coke of the highest grade can be used. It is quite necessary that the amount of sulfur compounds be low and that the amount of volatile matter be not excessive. Even the best coke contains appreciable quantities of sulfur which burns to sulfur dioxide during the process of combustion. It is imperative that practically all of this compound be removed from the flue gas, otherwise the sulfurous acid it forms in the coke tower reacts with the carbonate solution, producing the corresponding sulfite which soon becomes oxidized to the sulfate. Not only does this decrease the strength of the lye solution but the presence of the sulfate in considerable quantities is quite undesirable.

In order to decrease the sulfur dioxide content of the flue gas as much as possible it is washed with water in scrubbers packed with limestone. The sulfurous acid formed with this wash water reacts with the calcium carbonate, liberating carbon dioxide and forming the soluble calcium acid sulfite which, in turn, is taken out of the scrubber with the wash water. Usually two or more scrubbers are connected in series and when properly operated will remove practically all of the sulfur dioxide. In addition to the sulfur dioxide the scrubbers also remove dust and carbon particles. The purified gas is then forced into the absorbing unit for the removal of the carbon dioxide.

The Liquefaction of Carbon Dioxide.—The pure carbon dioxide is taken from the gasometer to the compressor through some form of drying apparatus. In some cases, a washing apparatus is placed between the

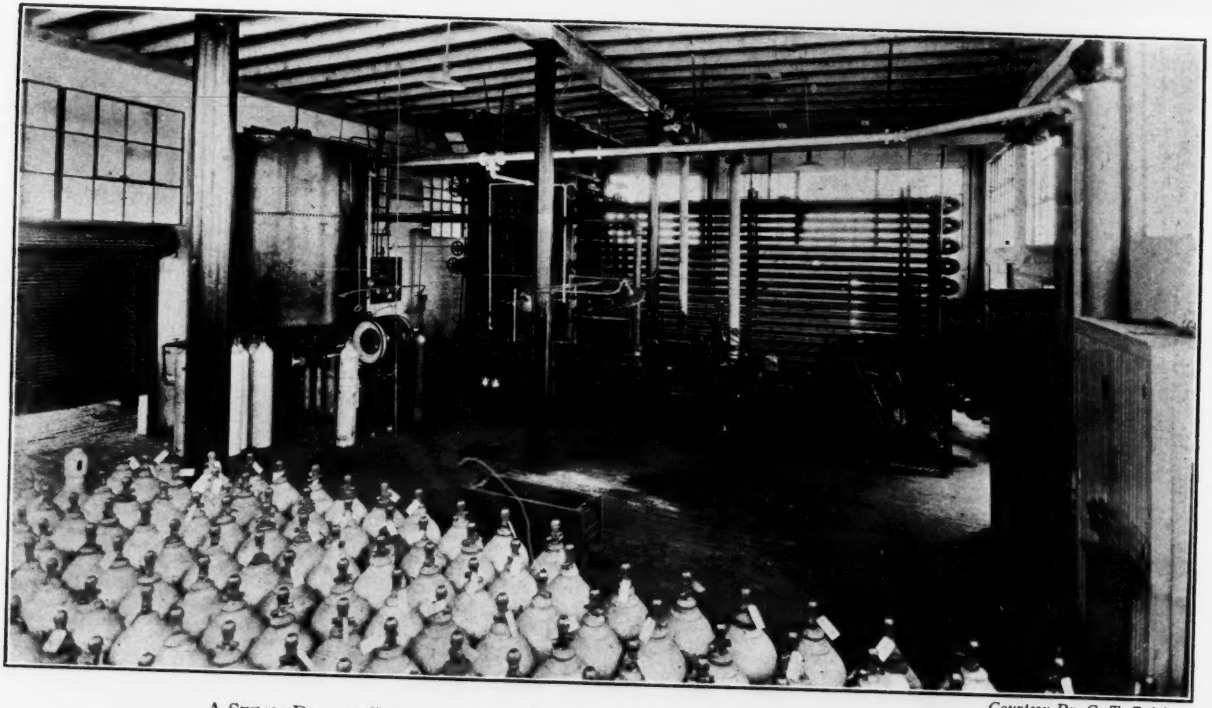


A CARBON DIOXIDE DEHYDRATOR WITH THE REFRIGERATION MACHINE AND AUTOMATIC CONTROL SYSTEM SHOWN IN FRONT OF THE GASOMETER

gasometer and the dryer in which the gas is washed with a dilute solution of potassium permanganate. The object of this treatment is to oxidize any organic matter that might get into the carbon dioxide and so produce an odor foreign to the pure gas. How effective such a treatment may be is hard to say, but the fact remains that some manufacturers think highly of it.

Drying, where it is attempted, is usually accomplished by means of a calcium chloride tower. This process is not always popular with the plant manager and it is more surprising to find one working properly than otherwise. A rather modern process for the dehydration of carbon dioxide takes advantage of the lowering in the partial pressure of water vapor produced when the temperature is lowered. Dehydrators of this type are often found in ice plants where they are employed to dry the air used for agitating water in the ice cans. As used to dry carbon dioxide, this apparatus consists of a vertical cylinder, provided with refrigerating coils and partly filled with a strong salt solution. The refrigeration is brought about with a small automatically operated refrigeration machine. The carbon dioxide is bubbled through the brine and gives up a large part of its water to it. Means are provided for adding solid salt and drawing off the excess brine each day. With a modern refrigeration apparatus, this process is indeed efficient, and is a distinct addition to any carbon dioxide plant.

Compressors for handling gases at high pressures have been developed to a high state of perfection, therefore it is not surprising to find this heavy



Courtesy Dr. G. T. Reich

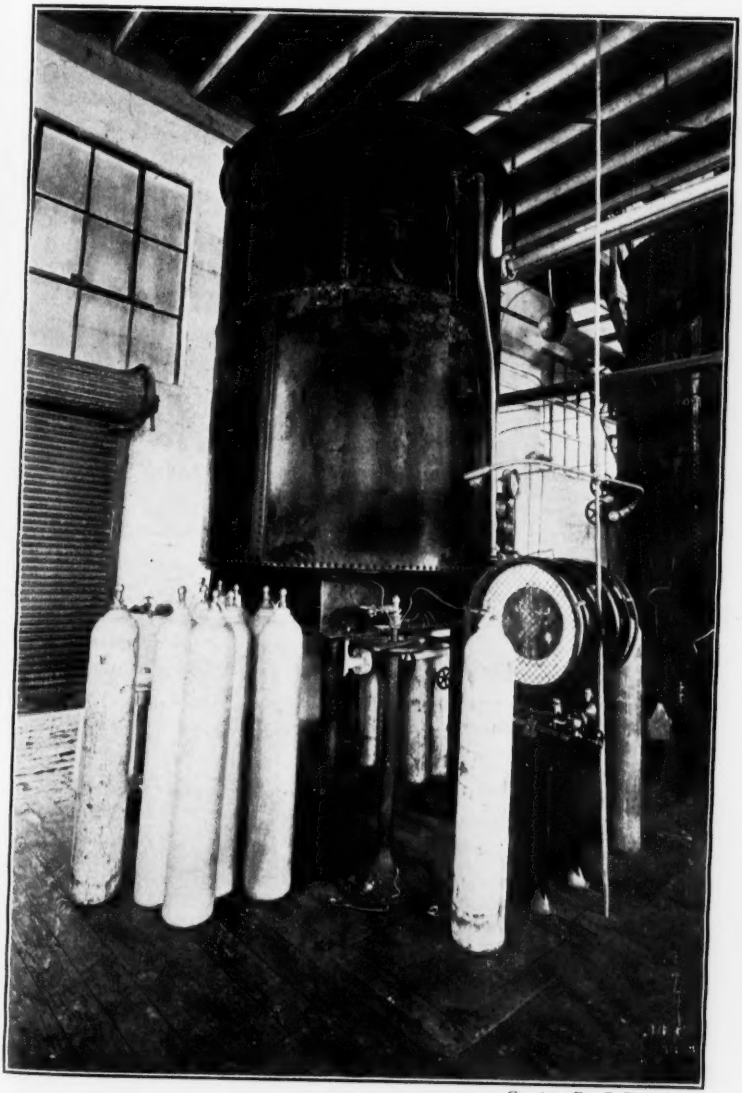
A Steam-Driven Carbon Dioxide Compressor with Heat-Exchangers in the Rear

duty performed without trouble. Carbon dioxide is usually compressed in three stages; the first takes the gas to about 90 pounds per square inch, after which it goes through an intercooler to the second stage; here a smaller cylinder is used and the pressure increased to about 600 pounds per square inch and again it is cooled before going to the third and smallest cylinder in which the pressure is raised to about 1000 pounds or higher. The proper lubrication of these compressors has always been somewhat of a problem. The old time lubricating oil gave to the carbon dioxide an undesirable odor which lowered the grade of the product. Then glycerol became popular with many operators and was used to a large extent for lubricating compressors. While glycerol does fairly well in some cases it is not an ideal lubricant. Small amounts of water destroy what lubricating value it does have and any local heating in a compressor may decompose this compound, resulting in decomposition products of extremely bad odor. The general practice now is to use a highly refined mineral oil which is without odor or taste, and has only a slight color.

Condensers and Filling Stand.—From the compressors, the hot, highly compressed gas is conducted through an oil trap to separate any entrained oil droplets and then to a water-cooled condenser. With the removal of the heat of condensation, the compound becomes a liquid and is now ready to be run to the filling stand and be charged into steel cylinders. These cylinders stand on the platform of a scale which registers the weight of the carbon dioxide added, which if standard cylinders are used will be either 20 or 50 pounds. The liquid in these cylinders occupies about 60% of the total volume, the rest of the space being filled with its saturated vapor. It is necessary to control this liquid volume carefully so as to allow enough space for the liquid to expand if the temperature is raised. To prevent over-filling and the consequent danger to persons handling these cylinders, the Bureau of Explosives periodically inspects carbon dioxide plants and carefully checks the weight of charged cylinders.

Coke and Air as a Source of Carbon Dioxide.—In the preceding discussion the general operations characteristic of any absorption process have been given. It is to be expected, however, that the arrangement of these units and the details of operation would vary somewhat with the raw materials used for making the carbon dioxide. From the standpoint of the engineer, the process in which coke is used for making the carbon dioxide is by far the most interesting. This is because of the delicate balance necessary between heat, power, and rate of production of carbon dioxide. The process is indeed one of the most carefully adjusted and balanced of all industrial chemical operations.

Burning the Coke.—A flue gas with a high carbon dioxide content is made by burning a high-grade foundry or metallurgical coke on the grate



Courtesy Dr. G. T. Reich

THE FILLING STATION OF A CARBON DIOXIDE PLANT SHOWING THE SCALES AND THE WATER-COOLED CONDENSER ABOVE

of an ordinary furnace. With proper care in firing and with a furnace setting free from leaks, it is possible to make a flue gas containing carbon dioxide up to about 18% or a little better. It is not possible to reach the theoretical limit of 21% due to the tendency to form carbon monoxide and for other reasons. The formation of carbon monoxide is kept as low as possible by limiting the depth of the fuel bed to about 12 to 18 inches, having a large grate area so the temperature can be kept reasonably low and carefully controlling the admission of secondary air over the top of the fire. The analysis of a typical flue gas before going through the absorbing unit and afterward, is as follows:

Component	Before absorption %	After absorption %
Carbon dioxide	17.37	9.10
Carbon monoxide	1.04	1.32
Oxygen	2.52	3.00
Nitrogen (by difference)	79.06	86.58

The heat from the burning coke is used directly for boiling lye or it may be used to produce steam which is used, first, for the production of power and, finally, to heat the lye boiler. The former method is used when the plant is operated by electricity and the latter where it is operated by steam power.

In a steam plant the live steam from the boiler is first used for operating the compressor engine, for running the fan engine and the pumps. The fan engine, which serves to move the flue gas up through the coke tower and to produce a draft on the furnace, is made to automatically control the steam pressure with a special type valve which increases the speed of the engine when the steam pressure falls. The pumps also are regulated by throttle valves connected to floats so they keep a constant level of liquid in the lye boiler and the feed water tank.

The exhaust steam from all of the engines and pumps is led into a header, through a steam trap, to the heating coils of the lye boiler where it is condensed in boiling the lye and the condensed water run to a feed water tank from which it is returned to the steam boiler. A plant of this type is nearly automatic in its operation and about all that is necessary for the operator to do is to keep coke on the fire and to take away the carbon dioxide cylinders as they are filled.

Limerock or Magnesite as a Source of Carbon Dioxide.—Some plants use the waste gases from a lime kiln or a magnesite burner as the source of carbon dioxide. The gases coming from a lime kiln will run as high as 40% carbon dioxide and, with the absorption process, a very large part of this can be recovered. The lime which is also produced as a by-product, with a favorable market, aids greatly in reducing the cost of production of the carbon dioxide. Power for operating a plant of this type must be

obtained from electricity or from a separately operated steam plant. The cost and availability of the raw materials determine to a great extent the most economical type of plant for any locality.

The Suerth System for Producing Carbon Dioxide.—This process is of interest more especially for its unique features and ingenious arrangement than from any practical advantages over the systems already described. No plants of this type are in operation in this country but it is understood that several are in existence in Germany where the process originated.

This process recovers the carbon dioxide from the exhaust gases formed by a gas engine operating on producer gas. The producer gas is made in a generator of the suction type, charged with coke or a high-grade coal. In this generator, air drawn through by the action of the engine reacts with the coke to produce a gas rich in carbon monoxide. Steam is added to reduce the temperature of the generator whenever necessary and results in the formation of some hydrogen as well as carbon monoxide. These gases are washed in a scrubbing tower with water and are taken into the engine where the carbon monoxide and hydrogen combine with oxygen, producing mechanical energy and forming carbon dioxide and water.

The removal of the carbon dioxide from the exhaust gases discharged from the engine is accomplished in much the same way as in the coke process. The heat contained by these gases is utilized in a lye boiler in which the strong lye is boiled. Then they are scrubbed in towers packed with lime rock for the removal of dust and sulfur dioxide. An air compressor next raises the pressure of the gases to about 50 or 75 pounds per square inch and forces them into the absorber or coke tower. The temperature of the lye solution, during absorption, is kept very near the boiling point and the reaction of the carbon dioxide and carbonate to produce the bicarbonate is due to the increased pressure of the carbon dioxide. A relief valve on top of the absorber discharges the residual gases into the atmosphere.

During the absorption process, the temperature of the lye solution falls somewhat below the boiling point. In the lye boiler the temperature is again raised to the boiling point by the heat from the hot exhaust gases, and the pressure of the carbon dioxide above the lye is reduced by means of a compressor so that the bicarbonate solution gives up carbon dioxide readily with the formation of potassium carbonate. This weak lye solution is forced, under pressure, back to the absorber for more carbon dioxide and goes through the cycle again. The first compressor in the system operating on the carbon dioxide not only serves to reduce the pressure of the carbon dioxide above the boiling lye, but it also acts as the first stage in the final compression of the carbon dioxide. This product is then dried

and goes to the second and third stages of the compression system after which it is condensed and run into cylinders for the trade.

The most important reactions taking place in this system may be represented by the following equations:

In the generator: $2C + O_2 \rightarrow 2CO +$ heat.

In the engine: $2CO + O_2 \rightarrow 2CO_2 +$ mechanical energy.

In the absorber due to the increased pressure of the carbon dioxide: $K_2CO_3 + H_2O + CO_2 \rightarrow 2KHCO_3$.

In the lye boiler due to the high temperature and the decreased pressure of the carbon dioxide: $2KHCO_3 \rightarrow K_2CO_3 + H_2O + CO_2$.

The Etymology of "Chemistry." Undoubtedly all of us can define chemistry broadly as the science which treats of the composition of matter, and a chemist, one who is versed in the art of chemistry. How many of us are familiar with the story of the origin and the derivation of the word chemistry?

Writers upon this subject are not agreed from what Zeus the word sprang. Five or six different versions of its derivation are given, but all cannot be true. Undoubtedly the science is a direct offspring of *alchemy*, or the art of transmutation.

The word *chemeia* is first found in an astrological treatise compiled by one Julius Firmicus, a writer of the 4th century A. D. It seems to have applied to the art of metal working, especially to transmutation. At first the art was called the *sacred art*, finally the word *chemeia* replaced it, then came the Arabic modification *alchemy*, until the 19th century spelled *alchymy*. It is said to be a compound word, from the Arabic definite article *al* and the Greek word *chyma*, signifying things melted and poured out.

Others believe that it is more probably derived from the Greek *chem* or *khem* meaning black, as applied to the "land of Egypt" so named from the dark color of its soil, composed of crumbling syenite. According to this derivation, alchemy is the *art of the black country*, the *Black Art*, which at one time was carried on in Egypt to a high degree of development.

According to others, and it appears convincing, the word is derived from the Hebrew *chaman*, meaning mystery, secret, occult. There is much proof that the early Jews were well versed in the art of metal working, fermentation, dyeing, brickmaking, etc.

The ecclesiastic version (or the Feministic Legend) of the origin of the word is quite interesting.

Early Jewish writers held that man was expelled from Paradise because of his (more likely her) desire to learn the *secret* and *mysterious* (chaman). This same idea was current among the Phoenicians, Persians, Magi, and the Greeks. It is to be found in the legend of Sibylla, who demanded, as the price of her favor to Phoebus, a knowledge of the *divine arcanum*, the art of the use of charms, precious stones, painting of the eyebrows, etc., things which are of especial interest to women.

Zosimus, an Alexandrian Greek alchemist of the 4th century, says: "the sacred or divine arts were revealed to man by angels fallen from their high estate through their love for mortal maidens." These secrets were revealed in the book called *Chemea*, *Chemes*, or *Chymes*.

However, it is man who is undoubtedly responsible for the origin of the chemical art. The making of wines, fermentation of alcohol and vinegar, the working of metals, and of brickmaking were known long before the legendary stories.—*Detroit Chemist* via *The Accelerator*

EXPLOSIVES; A BURLESQUE LECTURE*

LOUIS C. JORDY, DREW UNIVERSITY, MADISON, NEW JERSEY

Foreword: Just before the lecture is due, a heavy explosion is heard offstage. The master of ceremonies looks worried and sends some one out to investigate. The investigator returns shortly and holds a whispered conference with the M. C., who then announces that PROF. VACUUM, who is to address the audience on "Explosives," has been detained a few minutes, but will appear soon. After a suitable pause PROF. V. enters, a bandage around his head, hair dishevelled, one side of his face blackened by powder smoke, red stains on front of dress shirt, one lens of his pince-nez glasses cracked (cracks made with French chalk). He begins talking in a very agitated fashion:

PROF. V.: Ladies and Gentlemen: Apparently it is my misfortune to be late whenever I have the privilege of addressing you; but really I feel that this time the fault was not my own. . . . . ah. . . . . You see, when the insurance company learned that I was to present a lecture here this evening on the subject of explosives, their representative came here and insisted on suspending the policy on the building for the evening; and while my assistant, HERR TONIC, and I were engaged in demonstrating to him the harmless nature of our experiments, there was. . . . . ah. . . . . a bit of an accident (gets out red-stained handkerchief and dabs at spots on shirt-front), and I was detained until the gentleman could be removed. . . ah. . . . . to a hospital. Fortunately, he is right-handed; so the loss of the three fingers from his left hand will be no serious. . . . . ah. . . . . may I say *handicap?* Naturally, the incident was a trifle disturbing, and. . . . . ah. . . . . Oh, yes! (Demonstration No. 1: Sees the pitcher of water and a *dry* glass in which have been placed some small pieces of metallic K. Pours himself a drink, and the potassium takes fire and explodes. He jumps, then tiptoes cautiously to end of table and pours water in a waste jar. Demonstration No. 2: The waste jar, previously thoroughly dried, contains a mixture of Na_2O_2 and sawdust; when water is poured in, the mass ignites and burns explosively. PROF V. is badly rattled; sets glass down with exaggerated caution and backs away. Forces a smile and resumes lecture):

PROF. V.: Now I should confess at the outset of my lecture that I can make no claim to being an authority on explosives, my own researches

* Presented before a joint meeting of Alpha Chi Sigma and Pi Delta Nu, Syracuse University, Feb. 27, 1929.

Students at Syracuse have for a number of years been entertained by a series of burlesque scientific lectures presented by that amiable but very absent-minded scholar, Prof. Phineas T. Vacuum, D.Ph. (Prof. Jordy), assisted by his irascible colleague, Herr T. U. Tonic of the University of Pinaud (Prof. G. M. Edell). Two earlier lectures have been published in the *Hexagon* of Alpha Chi Sigma. Copies of "All Wet—A Scientific Treatise on Water," a companion lecture to "Explosives," may be obtained by addressing Prof. Jordy, Drew University, Madison, N. J.

being confined, as some of you may know, to the development of much-needed substitutes. At present I am working on a method for employing *flour* in place of the materials now used by bakers in the crusts of restaurant pies—so far, I regret to say, without success. It is my faithful colleague, HERR TONIC, who deserves to be called what you Americans so aptly term "the big noise" in the field of explosives. . . . . May I have the privilege of introducing to you my assistant, HERR TONIC, of the University of Pinaud. (Goes to door and calls HERR T., who enters very much the worse for wear—head and hands bandaged, face powder-blackened, strips of court-plaster, etc.)

PROF. V.: Ladies and Gentlemen: My colleague, HERR TONIC. (HERR T. bows, takes several sticks of "dynamite" and a coil of real fuse, with dummy fulminate caps, from his pockets and throws them carelessly on table. PROF. V. recoils, then resumes):

PROF. V.: Now, frankly, I feel that our demonstration this evening will not be a very *finished* performance. The events of the evening have made me a bit nervous, and I must ask your indulgence if I refresh my memory occasionally from my. . . . . ah. . . . . notes. (Feels in inner pocket without results, hastily searches all his pockets; finally appeals to HERR T.): HERR TONIC, do you recall what I did with my notes? (HERR T. impassively reaches in another pocket and brings out the "notes"—a shredded mass of papers, scorched on the edges and blackened beyond all legibility. PROF. V. thanks him and continues): Now I have brought with me some samples of nitroglycerin, guncotton, etc. . . . . (Cautiously lifts black bag from floor to table and turns to arrange the "dynamite" thrown down by HERR T. Bag is heavily weighted at one end, and is so placed that as soon as released it tips up and crashes heavily to floor, where the real samples have already been concealed beneath the table. As the bag drops, both men jump convulsively and register extreme fright.)

PROF. V.: My word! Careless of me, I'm sure. (Stoops and picks up samples, apparently from bag, placing them along front of table. Finally picks up bag, extracts specially prepared dummy stick of dynamite, and—Demonstration No. 3—throws bag onto some nitrogen iodide previously concealed under table. At the explosion PROF. V. starts, hastily consults notes, then counts the specimens): Now that is *too* bad. I find I overlooked one specimen of fulminate of mercury. . . . . Oh, well! . . It doesn't matter now.

Now, the earliest explosive was the familiar black gunpowder, which, as every one knows, consists of. . . . . ah. . . . . ah. . . . . Excuse me! (Consults notes). . . . . Oh, yes. Which consists of sulfur, charcoal, and saltpeter. (Shows actual samples of these.) It was first made by the Chinese, who, being an unprogressive people, failed to realize its splendid usefulness in killing their fellow men. It was left to our own advanced civiliza-

tion to develop the business to a fine art many centuries later. I have here (displaying them) several specimens of gunpowder; but I regret to state that our largest and best sample was lost just a few minutes before the start of the lecture. The insurance representative, of whom I have already spoken, in examining the canister inadvertently knocked the ash from his cigaret into it—and, do you know, more than half that powder burned up before we could put it out! Nevertheless, as you doubtless know, gunpowder is rated as a low-powered and rather inert explosive, which does not ignite unless heated. I might demonstrate by heating a little in this test tube, which I shall first dry thoroughly. (Demonstration No. 4: Several test tubes containing explosive mixture of H_2 and O_2 are standing mouth downwards in a beaker containing a little water. PROF. V. picks one up and holds mouth to Bunsen flame. At the explosion he drops tube and looks suspiciously at HERR T., who has taken out a copy of the *Police Gazette* and pretends to be deeply interested in its pages.) . . . . . ah. . . . . Possibly I had better heat it on this plate. (Demonstration No. 5: Pours out some "pyrophoric carbon" onto an asbestos plate; it ignites spontaneously.) . . .. If you don't mind, I shall consult my notes. (Looks at notes, then at label on tube of pyrophoric carbon.) . . . . Well, really, I am afraid this specimen was not properly sterilized before sealing. . . . . Suppose we try another sample. (Very cautiously opens another bottle containing coarse sand coated with graphite. Nothing happens; he regains confidence). . . . . Now, if I heat a little of this in a crucible. . . . . (Demonstration No. 6: Pours blackened sand into a crucible containing some previously prepared and dried nitrogen iodide, which explodes viciously.) . . . . ah. . . . . If you don't mind, shall we pass on to some of the really *powerful* modern explosives?

Now, one of the earliest of these was nitroglycerin, made by treating ordinary glycerine with. . . . . ah. . . . . (Consults notes and then appeals in a whisper to HERR T., who whispers back angrily.) . . . . ah, yes! . . . . by treating glycerine with "*Dummer Esel*"—whatever that may be. (Picks up Demonstration No. 7; sealed tube of thin glass containing zinc ethyl). . . . . Now, glycerine itself, as you must know, is a perfectly harmless liquid, non-explosive and even non-inflammable. . . . . (Accidentally drops zinc ethyl, which inflames spontaneously). But when glycerine is treated with. . . . . ah. . . . . with what I said a moment ago, we obtain this highly sensitive, oily, yellowish liquid called nitroglycerin. Notice the oily nature of the substance. (Picks up bottle, Demonstration No. 8, and tilts it about while talking.) . . . . In spite of the great danger connected with nitroglycerin. . . . . (about this time the stopper of the bottle blows out with a loud pop. PROF. V. jumps, sets bottle down very cautiously and addresses HERR T.). . . . . HERR TONIC, you will please remove the specimen from the room. . . . . and if you drop that bottle, you need not

come back! Now. . . . . as I was saying, in spite of the dangerous character of nitroglycerin, it is much used in mining operations. . . . . And by the way, I might say that three-fourths of the explosives made in this country are used in mining. . . . . ah. . . . . this estimate does not include the city of Chicago, of course. . . . . and I am told that the year just past was decidedly a boom year for the explosive business in Chicago.

Now, for military purposes a highly sensitive liquid explosive is out of the question, and so we come to the various smokeless powders, which are made, as I understand it, by a patented process which dissolves out the smoke from ordinary gunpowder. The resulting product is compressed into grains of various sizes (displays samples, either genuine or dummies) which are perfectly safe to handle, but which burn with extraordinary rapidity when ignited. . . . . I shall demonstrate this. . . . . (Demonstration No. 9; Lights a fake powder grain, a cylindrical rod about 1 × 2 cm., made of HgCNS and a little glucose. It burns interminably, with "serpent's egg" effect.). . . . . Dear me! I fear some important vitamin must have been left out in this case.

The Great War brought about the development of what might be called the *last word* in military explosives—T. N. T. (Displays fake sample.) Those letters, I understand, have some connection with the formula of the substance, but. . . . . ah. . . . . at this moment their meaning escapes me. Now, T. N. T., as you will note, looks about like corn meal, and is just as harmless under ordinary conditions. The remarkable thing about it is the extraordinary power it can exert while at the same time being entirely insensitive to severe shocks. For example, I place a little of it on this anvil, and may pound it with a hammer with perfect safety. . . . . (Demonstration No. 10: Pounds a mixture of $KClO_3$ and S, which explodes violently.) . . . . Well! If that is the *last word* in safe explosives, then so far as I am concerned, some one else is welcome to the last word.

Now I thought it might interest you to see the actual preparation of a stick of dynamite for firing. . . . . (With appropriate explanation, goes through process of crimping a dummy fulminate cap on real fuse, inserting latter into specially prepared fake stick dynamite; Demonstration No. 11, and getting ready to fire.) This fuse is timed to explode in ten seconds, but naturally I have no intention whatever of lighting it. I might, though, light a small bit of the plain fuse, to show how it burns. (Hands prepared stick of "dynamite" along with piece of plain fuse to HERR T., strikes one of the wax "vesta" matches and holds it while talking. The wax match—Demonstration No. 12—should be timed to burn at least one minute.). . . . . You know, in this connection I heard a most amusing story the other day about a workman in a stone quarry, an Irishman whose name was Pat—or was it Mike? Let me see. . . . . (pauses). . . . . well, at any rate, it doesn't greatly matter. This Irishman was carrying

a large case of dynamite when unfortunately he stubbed his toe and dropped the case, with rather disastrous results. The foreman in charge heard the crash and came running up; and he asked one of the other workmen—also an Irishman—"Where's Mike?". . . . . Or was his name Pat? (Pauses.) . . . Oh, well, that's not important—The foreman asked where he was, and the workman answered: "He's gone away." The foreman said, "Gone away? Well, when will he be back?" And the workman said: "Well, if he comes back as quickly as he went away, he will be here yesterday!" (While this monologue has been running on, HERR T. has been fidgeting about with the fuse and dynamite stick, and now, as PROF. V. holds out the still burning match, he puts the fuse of the supposedly genuine stick in the flame. It ignites, and PROF. V. suddenly realizes what has happened.)

PROF. V.: Good Heavens, man. You've lighted the wrong fuse. Get that out of here. It will explode in ten seconds! (HERR T. promptly throws the stick at PROF. V. and drops under the table. PROF. V. dances about in a panic of indecision and throws stick to a confederate in the front row of the audience. The latter at once throws it back, whereupon PROF. V. drops it on the lecture table and crawls underneath. From this shelter he and HERR T. bob up alternately until 10 seconds have elapsed, when they slowly emerge together both badly scared.)

PROF. V.: Ladies and gentlemen, I shall not attempt to apologize for the stupid blunder of my colleague, but will only say that I am deeply thankful that by some miracle the fuse of the charge failed to explode. (Picks up dummy stick and notices something peculiar in its appearance). . . . . Why, what's this?. . . . (Unrolls outer covering, disclosing inner wrapper of tissue paper, which in turn reveals a large stick of striped peppermint candy. Holds up candy, looks at HERR T., who meantime has edged toward the door, and reaches determinedly for hammer.) . . . . Ladies and gentlemen, at the beginning of my lecture I expressed a fear that it might not be a *finished* performance. . . . . I must correct that statement. . . . . Except for one minor detail (brandishing hammer and rolling up sleeve), this performance is now FINISHED! Good-night! (Dashes off-stage in pursuit of HERR T.)

C-U-R-T-A-I-N

Detailed Directions for Demonstrations Used in the Lecture on "Explosives"

In working out the demonstrations for this lecture, a studied effort has been made to limit the materials and stage properties to those available in the ordinary high-school laboratory or capable of preparation by students of elementary chemical training. None of the tricks need be at all dangerous if ordinary care is exercised.

Demonstration No. 1—The glass must be *dry*. The pieces of potassium should not be much larger than a pea. It is advisable not to prepare this set-up too long in advance, as the potassium collects moisture from the air and may take fire spontaneously.

Demonstration No. 2—The sawdust should not be too fine. About 5 parts sawdust to one part Na_2O_2 should work satisfactorily. The action tends to be violent; see that it does not spread beyond the waste jar.

Demonstration No. 3—Nitrogen iodide is prepared by soaking crystals of iodine in *concentrated* ammonia solution for a few minutes, then spreading on filter paper to dry. It is quite safe to handle when wet, but extremely sensitive to shock when dry. Use only small amounts and handle cautiously.

Demonstration No. 4—"Detonating gas" consists of hydrogen, 2 parts; oxygen, 1 part. The test tubes are readily filled from tanks or convenient generators by displacement of water. Do not try to generate the hydrogen on the spot by putting sodium in the test tubes.

Demonstration No. 5—Pyrophoric carbon is readily made by heat decomposition of lead tartrate, prepared by bringing together in solution calculated amounts of lead nitrate and of Rochelle salt (sodium potassium tartrate). The precipitated lead tartrate is filtered by suction, dried, and ignited in a hard glass test tube until no further volatile products escape. The tube is then tightly stoppered while still hot and the stopper coated with paraffin. When opening, hold tube as high as possible and shake out contents with a sweeping motion.

Demonstration No. 6—Nitrogen iodide prepared as for No. 3, placed on a small pad of filter paper inside a crucible and dried with great care. The "gunpowder" made by shaking coarse sand with a little finely powdered graphite cannot be distinguished from the genuine article, but is perfectly inert.

Demonstration No. 7—If zinc ethyl is not readily obtainable, this demonstration may be omitted. If used, the glass container must be thin enough to break easily when dropped.

Demonstration No. 8—A piece of test tube with flattened bottom is cemented by means of "water glass" inside an ordinary wide-mouth bottle. A label at the proper height conceals the mouth of the test tube, which is filled with a saturated solution of potassium acid sulfate (or sulfuric acid may be used). The bottle itself contains a saturated solution of sodium bicarbonate, colored slightly yellow with methyl orange. Mix the two solutions by tilting. A good cork stopper makes a louder report than a rubber one.

Demonstration No. 9—Mercuric sulfocyanide is easily made by mixing solutions of mercuric chloride and potassium sulfocyanide in calculated amounts. The precipitate is dried, mixed with some dextrin or glucose

as a binder, and molded into cylindrical rods resembling the "grains" of smokeless powder used in big guns. Additional dummy specimens are readily made from pieces of broomstick, etc. In general, the length of a grain is about twice its diameter.

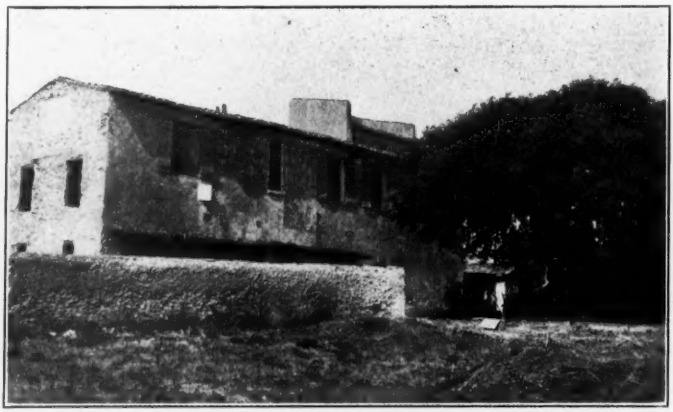
Demonstration No. 10—A good imitation of T. N. T. is made from land plaster (calcium sulfate) tinted a light yellow by adding powdered sulfur. This mixture is practically inert and may be used to fill a large bottle. A smaller container holding a few grams of the potassium chlorate—sulfur mixture—may be buried in the mass. CAUTION! Powder the sulfur and the potassium chlorate separately and mix by folding gently together on a paper. Do not attempt to mix by grinding, and make up only a few grams at a time. Throw any unused portion in the sink after the lecture and flush down with water.

Demonstration No. 11—The special stick of fake dynamite used in this trick is made from a large stick of candy wrapped in many folds of tissue paper and finally inclosed in the usual oiled cartridge paper used for real dynamite. It should have the word "DANGER" printed in large red letters on the outside. Other very convincing dummies are made from sections of wooden curtain pole wrapped in oiled paper and marked "DANGER." Fake fulminate caps are made by rolling up tubes of thin copper foil and soldering lightly down one edge. They should be of the diameter of a 22-cal. rifle cartridge—which serves as an excellent base for the cap. The waterproof fuse is obtainable at hardware stores: it burns at the rate of about 2 seconds to the inch. It should be split or cut on a slant, and is best dipped in some "match head" mixture to insure quick ignition.

Demonstration No. 12—Wax "vesta" matches are rarely on sale nowadays. Get some of the wax tapers used in barber shops and cut into lengths. The heads of ordinary Swedish safety matches may be grafted into these wax stems with the help of a few turns of white thread. A wax match so made, having the same length as the ordinary safety match, will burn for a full minute if held upright. To get the maximum effect of suspense, Prof. V. should not even glance at the match while telling his story, and should not give the slightest evidence of being hurried. This requires careful timing.

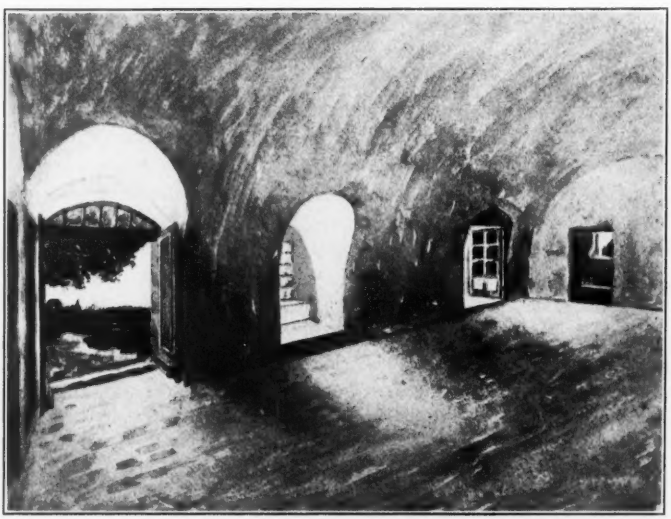
First World Rayon Exhibition. From information received from the *Dechema* (Deutsche Gesellschaft für chemisches Apparatewesen E. V. Seelze, near Hanover), we learn that the first world rayon exhibition will take place on the occasion of the Sixth Achema, to be held at Frankfurt-am-Main between June 10 and 22, 1930. There is to be a special exhibition section for machines and appliances for the manufacture of rayon, which will show the latest technical development in the production of rayon, and will be under the direction and coöperation of the leading experts in the trade.—*Chemistry and Industry*

FORMER ROYAL HUNTING LODGE NOW PAPER LABORATORY



These photographs show one of the oldest, if not the oldest, building in the world that is at present used as a chemical laboratory. It is "La Grande Estrade" at Marignane, Bouches-du-Rhône, France, erected in the 13th Century as a fortified hunting-box for the Grand Seigneurs of Provence, and later occupied by Mirabeau. It is supposed to be the oldest occupied building in Provence.

At present it is a paper-making laboratory of an American chemist, William A. Hall.

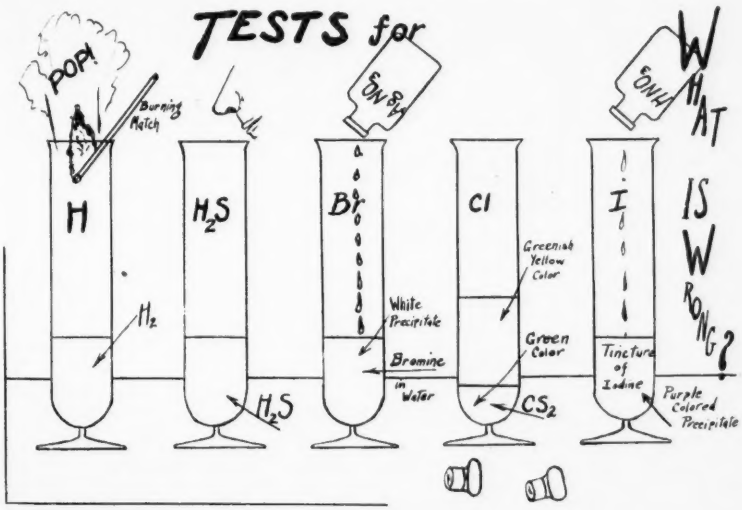


CONTEST FOR HIGH-SCHOOL AND FRESHMAN STUDENTS

On this page is reproduced the sixth of a series of drawings prepared for us by Prof. John J. Condon of William Nottingham High School, Syracuse, New York. Write a brief statement, telling what is wrong with the picture. Use complete sentences; do not merely list mistakes. Type your manuscript, if possible; if not, be sure that you write legibly. Type or write on one side of the paper only.

Make a correct drawing, showing the picture as you think it should be. Use black India ink and white drawing paper. (If you believe that you can draw better on coördinate paper, white paper with blue rulings must be used.) Drawings should be approximately 4″ × 6″ or 8″ × 12″.

Place your name at the top of each page of your manuscript and at the top of your drawing.



On a separate sheet accompanying your manuscript write your own name, the name and address of the institution at which you are a student, the name of your chemistry instructor, and the name of the chemistry club at your institution (if there is one).

Address your paper to: The Associate Editor, JOURNAL OF CHEMICAL EDUCATION, The Johns Hopkins University, Homewood, Baltimore, Md.

Your contribution to this month's contest must be postmarked not later than March 15th.

Awards

The best contribution received will be awarded a prize of five dollars. The five next best papers will receive awards of one dollar each.

Contributions will be judged on the basis of:

1. Correctness from a chemical standpoint
2. Neatness and correctness of drawing
3. English
4. Neatness and legibility of manuscript.

Papers which do not comply with all of the rules of the contest will not be considered.

Helium Heart's Affinity Gives New Atomic Knowledge. A story of chase and capture in the submicroscopic world of physics was related by Prof. Bergen Davis of Columbia to the National Academy of Sciences recently at Princeton.

Electrons excited and speeded by an electric field were made, in experiments performed by Prof. Davis and his associate, A. H. Barnes, to pursue the hearts of helium atoms, known as alpha particles, shot out by radioactivity at a velocity of 9000 miles per second. The objective was to make a helium nucleus seize and hold one or two of the electrons chasing along near it.

Only when the electron was in just the right condition of velocity was it captured and the velocities of capture corresponded to the energy levels of the electron satellites of the atom as pictured by physicists.

In one of the experiments the speedy electron and receptive helium nucleus were placed close together for so short a time that the electron could not have had time to fall by gravitational attraction like a meteorite pulled to earth by the force of gravity. Yet the electron was captured and this caused the experimenters to wonder if the alpha particle or the electron or both might fluctuate in size, becoming very large when they are about to unite and becoming exceedingly small at other times. The auras or spheres of influence would in this event change with the energy of the particles.

This new light on the behavior of the nucleus of the helium atom in making electrons its own is considered a step toward better understanding of the constitution of this important building block element.—*Science Service*

Science a Major Factor in Farm Relief. Solving the problem of spontaneous combustion will be an important contribution by science to farm relief, R. W. Dunlap, Assistant Secretary of Agriculture, pointed out to the Conference on Spontaneous Ignition and Heating of Agricultural and Industrial Products, at its recent session in Washington, D. C.

"Spontaneous combustion in barns and storage bins and haystacks costs the farmers of this country $30,000,000 a year by estimate, yet little attention has been paid to this loss. I do not recall an instance during the past eight years, when volumes have been printed concerning farm relief, in which this matter has even been mentioned as a means of helping the farmer. It is through this avenue and many other similar avenues that full relief will be obtained, and it is high time that our scientists were being supported financially and otherwise in solving this problem which is so costly to the American farmer. The Department of Agriculture has been doing some work along this line for many years, but the financial support it has received has not been sufficient to enable it to make much headway. It is hoped that more funds can be provided so that this important work can go forward more rapidly."

The only way to find out how to store agricultural products so that they will be least liable to destruction and damage by spontaneous ignition is for scientists to learn the exact nature of the chemical processes which take place in masses of materials that heat spontaneously.—*Science Service*

WINNERS IN FOURTH "WHAT IS WRONG?" CONTEST

Competition in the fourth contest[1] was unusually keen. The problem itself was relatively simple; hence there were comparatively few opportunities for omissions or mistakes. First-class papers, therefore, were not separated from second-class papers by so wide a margin as usual, nor did the prize-winners finally selected differ greatly in order of merit among themselves. Furthermore, the number of contributors was the greatest yet submitted.

As heretofore, greatest credit was given for observations relating to correct laboratory technic and to chemical facts. Criticisms of objects wrongly represented were also credited, provided that they touched upon points more fundamental than mere drafting technic. Greater weight was attached to statements accompanied by reasons than to bare assertions.

The paper which won first award, that of David Merrill, of Oakland, California, suggests slightly more elaborate provision for the cooling of the receiver than did those of most of the other contestants. No extra credit was given it on that account, however.

Mr. Merrill's discussion follows:

To avoid confusion and repetition I have tried to dispose of one correction at a time. You will find that first the mistake is stated, then the proposed remedy, and last the reasons for preference of the latter over the former.

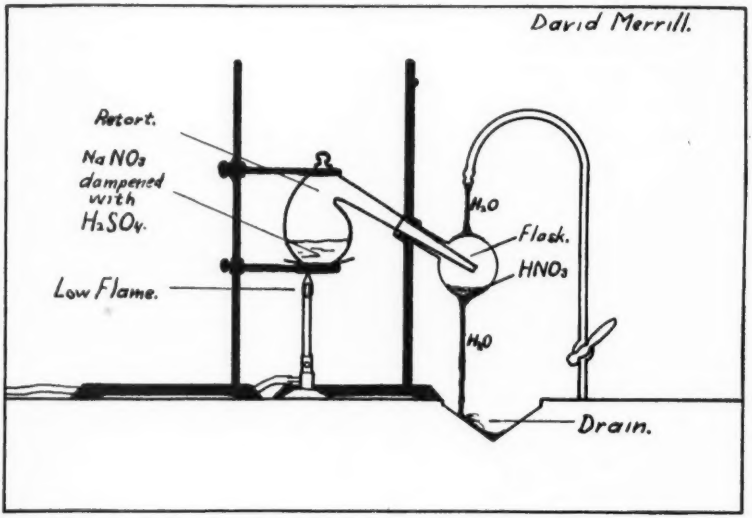
The first error noted was the use of hydrochloric acid (HCl) in the laboratory preparation of nitric acid. Sulfuric acid (H_2SO_4) should have been used because hydrogen chloride (HCl) is a gas and comes out of solution readily upon heating. Its solution in water (H_2O) is an acid. Water of solution will distil over, diluting the HNO_3 formed. The gas and distilled water will reunite to form HCl in the condensing chamber. This will prevent a 100% pure product. Concentrated sulfuric acid is nearly 100% acid and does not boil until 340 degrees Centigrade is reached. No water is used. If any water is contained in the sodium nitrate ($NaNO_3$) as dampness the pure acid will dry it, leaving the end-product nearly 100% pure HNO_3.

Secondly, there is shown too much acid in the retort. The reaction will take place satisfactorily with only enough concentrated acid to dampen the mass of $NaNO_3$ used. By atomic weights it is found that 85 grams of the nitrate will react chemically with 98 grams of the acid to form the desired product. Ninety-eight grams of sulfuric acid equals about forty-seven cc. which is just enough to dampen. To use more involves a waste of acid which is unnecessary and only increases the danger of serious damage in case of an accident.

The third mistake noticed was the height of the Bunsen flame. The flame is used only to vaporize the HNO_3, which boils at 86 degrees Centigrade at atmospheric pressure. Above this temperature decomposition tends to take place as HNO_3 is unstable at high temperatures. A product of this decomposition is a dangerous gas, nitrogen dioxide (NO_2) which is detected by a reddish brown color. Excess heat will drive this gas (by expansion) into the room with some uncondensed HNO_3.

The mouth of the retort was not inserted far enough in the mouth of the cooling

[1] See THIS JOURNAL, **7**, 167–8 (January, 1930).



receptacle. It should be inserted farther to prevent loss of vapors by providing greater opportunity for cooling and condensing.

The fifth mistake found was technical. The artist showed no air vent in the Bunsen burner. This I have remedied in my drawing. Air is needed to form a combustible mixture, otherwise the flame would be luminous and sooty and not so hot as the blue flame.

The illustration shows the retort unclamped. The retort should be clamped firmly to avoid accident and insure safety, as its concentrated acid is so destructive.

The test tube is not sufficiently immersed. A flask is suggested to replace the test tube as it provides a greater cooling surface. Moreover the cooling receptacle should be well immersed to provide a greater cooling surface. It is suggested to use running water to carry the heat away as I have illustrated.

The eighth mistake I discovered was the absence of water in the beaker. This, of course, should be immediately remedied in one of the ways suggested above. Water aids greatly in condensing the vapor as it has the property of absorbing large amounts of heat for but a slight rise of temperature. A moist cloth wrapped about the cooling receptacle is also another way of reducing the temperature of the cooling chamber—by evaporation.

Another glaring mistake or *faux pas* in laboratory technic was the placing of the books beneath the beaker. A ring stand or wood block should be used. Books are one's best friends, if properly used, and should be treated with respect. In case of accident 100% pure acid will cause great damage to the books.

A tripod is shown in the diagram presented to be corrected. The tripod shown has too high a center of gravity and is unstable. A lower tripod, of larger base area, is suggested if a ring stand is not obtainable. A ring stand is one of the most safe and useful of supports for laboratory use as it has a heavy base.

Lastly, one minor error in the drawing is the fact that the line of the table shows through the rubber hose.

Winners of one-dollar awards were: Byron Loder, Hutchinson, Kansas; Helen Gunnarson, Kingsburg, California; Laurence Brown, Worcester, Massachusetts; Winifred Loughlin, Brooklyn, New York; Kent Sandford. Floral Park, New York.

THE SCIENTIFIC MEDICAL

(*With apologies to the Shade of W. S. Gilbert*)

I am the very model of the Scientific Medical,
I know each nerve and artery, each ligament and pedicle;
My knowledge has been built by evolutionary processes
From Galen and Hippocrates to present-day Colossuses.
I've studied all the endocrines and know the various offices
Of pancreas and thyroid, or of thymus and hypophysis;
I know the suprarenals too, and all that they're related to— (—lated to, —lated to—ah!)
How benighted were the medicos who lived in 1882.

I know the pH value of ionical acidity;
I calculate percentages with wonderful rapidity;
And when it comes to artery or ligament or pedicle
I am the very model of a scientific medical.
I'm particularly expert at a Wassermann analysis;
I hunt for protozoa in a patient with paralysis;
The chemistry of insulin's a subject that I revel in,
And antitoxin therapy I'm just the very devil in.
I know the rôle of calcium in various forms of tetany;
I understand trypanosomes, although I've never met any;
And I've the latest news on perineural sympathectomy— (—pathectomy—ectomy—ah, I have it!)
My knowledge often bringing in a good substantial cheque to me!

I'm very strong on vitamins and matters dietetical;
I know the graphic formulae of remedies synthetical;
And when it comes to artery or ligament or pedicle
I'm just the very pattern of a scientific medical.

(*More slowly*)
When I've acquired some knowledge about matters pharmaceutical,
When I can diagnose a little deeper than the cuticle,
When simple indigestion has become a trifle clear to me,
When babies with the colic are no more a source of fear to me,
When I can write a recipe with ord'nary galenicals,
When I have learned the doses of the various arsenicals,
When highbrow scientific lore no longer needs a missioner— (missioner—condi—practi- —I've got it!)
You'll then consult me safely as a general practitioner!

For my scientific knowledge, though I'm always up to date with it,
Has kept me back in practice, and I'm just a little late with it;
But when it comes to artery or ligament or pedicle
You'll find I'm just the model of a scientific medical.

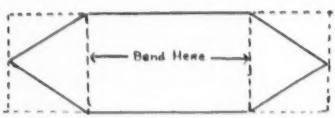
THOMAS STEPHENSON

From *The Prescriber*, via the *News Edition, Ind. Eng. Chem.*

A SIMPLE BISULFIDE SPECTROSCOPE

HOWARD JAMES,* UNIVERSITY OF COLORADO, BOULDER, COLORADO

Since Bunsen's development of spectrum analysis, the spectroscope has played an important part in chemistry. In the last year, it figured prominently in the discovery of isotopes of oxygen and of carbon. Although the spectroscope is essentially a physical instrument, it is hoped that because of its extensive use in chemistry, the construction of a very elementary instrument will be of interest to the readers of THIS JOURNAL.

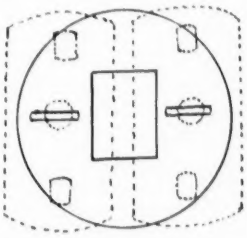


BRASS SKELETON OF PRISM

The bisulfide prism presents the greatest difficulty in the construction and it is in this heart of the spectroscope that success or failure lies. A piece of sheet brass $^1/_{16}$ of an inch thick serves as the skeleton. This should be cut one inch wide and about 2.8 inches long. Thoroughly cleanse the strip before proceeding further. On each end mark off an equilateral triangle, and cut as illustrated. Bend the triangles along the third sides at right angles with the original strip.

Lay a twelve-inch file flat on a table and smooth both cut surfaces of the brass form by drawing it across the file. As the job approaches completion, replace the file by a board over which a piece of emery cloth is stretched.

The brass skeleton furnishes one side of the prism. Photo glass should be used for the other two. The base glass of a microscope slide cut in two serves very well. Cleanse and dry the glass thoroughly, then glue one glass plate onto the brass. For this purpose, use glue made as follows: Boil together in a water-bath, five parts carpenter's wood glue chips, four parts water, and one part glycerin. The consistency of the glue is important, for if it is too weak, the prism will invariably leak. Use the glue while hot.



BRASS DISK WITH RAZOR BLADES TO FORM ADJUSTABLE SLIT

After the glue has hardened, which will take several hours, grind the glass edge at the peak of the prism even with the brass frame, using the file and emery cloth as before. Now glue on the remaining side, so that it overlaps the ground glass edge of the other side. Allow the prism to set for a day before filling with carbon bisulfide.

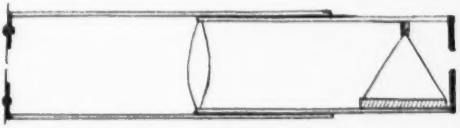
A much simpler, though inferior, prism can be constructed from a section of one-inch brass tubing. Cut a ring in such a manner that one cut surface makes a 60° angle with the other. Thoroughly cleanse the brass

* Winner of $10 award in undergraduate contest closing January 15th.

and file the cut surfaces smooth. Drill a small hole in the brass to allow filling. Glue on the glass sides, one at a time.

It is best to fill the prism with a medicine dropper having a fine point. When the prism is full, plug the hole with a tight-fitting wooden plug which is covered with the glue.

The construction of the spectroscope is clearly shown in the drawings. Two cardboard tubes which telescope are blackened on the inside. They form the case. A brass disk, also blackened, is fitted to one end of the larger tube. Safety razor blades, of the Gillette type, are fastened by means of small bolts to the slots on either side of the large hole. This forms an adjustable slit. Mount the prism near the eyepiece, and, in the same tube, mount a lens which is in focus with the prism. The writer used a lens taken from an old pair of field glasses. The eyepiece tube can be slipped back and forth in the large tube as desired.



BISULFIDE PRISM AND LENS MOUNTED IN THE SPECTROSCOPE

Many experiments are possible with the above instrument. The sodium spectrum can easily be obtained. By narrowing the slit, the Fraunhofer lines may be obtained, using daylight.

New Gem, a Deep Blue Zircon, Believed Colored by New Element, Hafnium. The new element, hafnium, may be the solution of the latest jewel mystery. A sparkling deep blue zircon, more beautiful as a gem than the usual brown, greenish, or yellow varieties of that mineral, puzzled jewelers and mineralogists when it appeared on the market from Australia, Ceylon, and other eastern countries about five years ago.

Dr. George F. Kunz, jewel expert of Tiffany's, who gave the new gem the name "Starlite," believed the mineral to be artificially colored, but knew no such beautiful color resulting from the elements known to occur in zircon. When he set about solving the mystery he learned that, although shipped from various places, the crystals of blue zircon all originated from a single place, near Chantaboon in Siam. There the brown mineral, before being cut, was heated with cyanide of potassium in a closed crucible for some hours, coming out a color ranging from nearly white to deep sapphire-blue depending on the length of the treatment.

Only the heavier varieties of the mineral, which occurs in an unusual range of weights will take on the blue color, and Dr. Kunz has found that the heavier kinds of zircon are the ones containing hafnium. He therefore believes that the mysterious color is a manifestation of this little-known element.

Hafnium was discovered in 1923 by D. Coster and G. Hevesy of Copenhagen, who found that it is a metal similar to zirconium, which is found in the mineral zircon. Although so long unknown, hafnium is by no means rare. It is believed to make up about $^1/_{200,000}$ of the earth's crust.—*Science Service*

THE LIBRARY

POPULAR SCIENCE MONTHLY, *February, 1930*

(*P. 25.*) "Announcing a $10,000 Annual Award." *Popular Science Monthly* announces that in September, 1930, it will make the first annual award of $10,000 to the American citizen who, in the opinion of the members of the Committee of Award, has been responsible for the achievement in science during the year of greatest potential value to the world. The monetary prize will be accompanied by a gold medal.

(*P. 26.*) "Better Fuel for Better Motors." *E. H. Hamilton.* An outline of the early history of the oil industry and of some of the more outstanding developments which have allowed petroleum production and refining to keep pace with automobile demands. (Illustrated.)

(*P. 46.*) "Canal Paintings Saved from Ruin." *George Lee Dowd, Jr.* Until a few months ago the five mural paintings depicting the construction of the Panama Canal, canvasses covering four hundred square feet of wall space in the Administration Building at Balboa, were in danger of destruction from the ravages of mold. The treatment finally adopted consisted in washing off the former porous beeswax coating with alcohol and ether, destroying the molds by washing successively with thymol solution and ammonium hydroxide, and applying a new protective coating of paraffin. (Illustrated.)

(*P. 53.*) "Gems Fourteen Feet Long." Crystals of semi-precious beryl twelve to fourteen feet long and from two to three feet thick were recently discovered in a quarry near Albany, Maine.

(*P. 54.*) "Wood Fibers May Cut Cost of High-Grade Papers." Experiments at the Bureau of Standards may lead to chemical purification processes which will make possible the production of high-grade papers from wood pulp which is much cheaper than the linen and cotton rags now necessary.

(*P. 54.*) "Two New Vitamins Found by Women Chemists."

(*P. 57.*) "Volcanoes Help to Make the Ocean Salty." According to Dr. Thomas A. Jagger, of the Hawaiian Volcano Observatory, volcanoes give off hydrochloric acid gas which is eventually carried down with the rainfall. The dilute HCl solutions so formed act on sodium minerals in the earth to form NaCl which is ultimately washed into the sea.

(*P. 59.*) "Chemical Baths Valueless in Preserving Flowers." Salt, aspirin, etc., added to water in which cut flowers are standing does not make them last longer, according to the Boyce Thompson Institute for Plant Research. A moist atmosphere is the greatest aid to long life for cut flowers, and with many varieties a reasonably low temperature is also a help.

(*P. 115.*) "Home Workshop Chemistry." A number of tests for house paints are described.

SCIENTIFIC AMERICAN, *February, 1930*

(*P. 110.*) "How Old Is the Earth?" *Alfred C. Lane.* The writer discusses briefly a number of methods of estimating the age of the earth, or at least of setting maximum or minimum limits to the probable age. The most interesting of these from a chemical standpoint is the determination of the relative proportions of various radioactive elements and lead in certain minerals, and the calculation of the age of the minerals based on the known half-lives of the radioactive elements. (Illustrated.)

(*P. 124.*) "A Modern Inferno." *Martin Meyer.* In this essay the author sketches briefly the emergence of the science of chemistry from the mists of alchemy. He stresses the effect of the adoption of the "scientific method." The rapid growth of modern chemistry he ascribes to man's increasing power to control experimental conditions. In illustration he cites the extremes of temperature which can now be produced. (No doubt the title of the article has its origin here.) The author concludes with a few general observations on the chemist's contributions to civilization. (Illustrated.)

(*P. 141.*) "A Big Practical Problem for Science." *F. M. Jaeger.* Where will we turn for energy when the "canned" solar heat now available in the forms of petroleum and coal is exhausted? The writer points out that the utilization of radiant solar energy offers the only solution at all likely to furnish power and heat in the necessary quantities. He discusses briefly the experimental devices which have been tried so far, with particular emphasis on Dr. Claude's famous plan for employing the temperature difference between tropical surface water and deep-sea water. He speculates upon the possibility of employing photochemical processes, points out the limitations of known processes of this nature, and indicates some of the problems to be solved. (Illustrated.)

(*P. 156, et seq.*) "Chemistry in Industry." Includes the following items: "New Baking Powder Leaves No Traces in Bread." Acetonedicarboxylic acid, which decomposes on heating to give only volatile products, has been investigated and found to constitute a satisfactory baking powder. "Removing Calcium Sulfate Deposits from Pipes." Hot sodium carbonate solution, followed by dilute HCl, will completely remove calcium sulfate deposits from a pipe line. "Catalysis Reduces Cost of Acid." Ammonia is catalytically oxidized to furnish the oxides of nitrogen which in turn act as catalysts in the conversion of sulfur dioxide into sulfuric acid. (Illustrated.) "Different Dynamites for Specific Purposes." Specific examples are given. "Waltzing Mice Detect Poison Gas." Japanese waltzing mice are found to be more sensitive to low concentrations of carbon monoxide than canaries, which have previously been used as detectors of this deadly gas in mines. "Ultra-Violet Rays Said to Improve Flour." Flour irradiated with ultra-violet light is said to contain an abundance of

vitamin D and to show improved keeping and baking qualities. "All the Gold in the World Is Not So Much." It is estimated that all the gold produced since the discovery of America could be cast into a cube which would measure only 38.5 feet along one edge. "Rare Earths in Glass Produce Remarkable Effects." The power of glasses to absorb certain spectral rays is greatly influenced by the addition of small quantities of various of the rare-earth minerals. "Impregnated Hemp More Durable." A process for impregnating hemp with certain petroleum distillation residues greatly increases its durability, particularly when used in cordage, fish nets, water hose, etc. "New Borate Mineral Is Finding Commercial Use." A form of borax containing less than the usual amount of water of crystallization has recently been discovered in large quantities in the Mojave desert and is finding uses in the manufacture of special glasses and glazes. "'Tin Cans Made of Aluminum in Norway." The low cost of electrical energy in Norway, which makes possible the cheap production of aluminum, has led to experiments with aluminum cans for fish. "New Freezing Mixture." A German patent describes a new cooling mixture consisting of 100 parts ammonium chloride, 150 parts sodium carbonate, and 300 parts water, which gives a temperature drop of 31°C. This is much cheaper than previously known mixtures which give an equal cooling effect.

SCIENCE AND INVENTION, *February, 1930*

(*P. 905.*) "Nicotine—Methane—Phenol." *Louis Oberseider.* Directions for the laboratory preparation of these chemicals. (Illustrated.)

POPULAR MECHANICS, *February, 1930*

(*P. 240.*) "Prospectors Discard Metal Costlier than Gold." Three prospectors searching for gold in New Guinea recently threw away large quantities of a heavy, blue-gray metal. Later it developed that the discarded metal was osmiridium, a rare mineral containing osmium and iridium. Its value is approximately ten times that of gold.

(*P. 254.*) "Measure for Light Is Found after Twenty Years." Previous candlepower standards have all been unsatisfactory, either because of irreproducibility or because they deteriorated with use. The Bureau of Standards now presents a new yardstick—the light emitted by platinum at the fusing point.

(*P. 272.*) "Murals Are Saved from Mold by Poisoning Fungi." Essentially the same information contained in the third item on p. 668, but more briefly presented.

(*P. 279.*) "New Uses for Peanuts Found in Many By-Products." Peanut tops are used for hay; hulls serve as fuel, absorbents, fertilizer fillers, as a fiberboard ingredient, and a kind of sugar may be extracted from them; the seed germs and skins yield soap oil and stock feed; the nuts themselves furnish oil, flour, and other edible products.

Correspondence

BENJAMIN SILLIMAN, 1779-1864—A CORRECTION

Kindly permit me to call your attention to a slight error which occurs in the biographical sketch of Benjamin Silliman in the January, 1930, JOURNAL. According to the frontispiece accompanying this sketch, Silliman lived from 1779–1864, yet in the eighteenth and nineteenth lines of the first paragraph is the statement that he graduated from Yale in 1776, *three years before his birth.*

EDWARD M. GERSTENZANG

1560 E. 32ND STREET
BROOKLYN, NEW YORK

Editor's Note: We regret this error in proofreading. The date of Silliman's graduation from Yale should have been 1796.

CORRESPONDENCE-STUDY COURSE IN INORGANIC PREPARATIONS

We have recently made available for correspondence-study a course in Inorganic Preparations. This course has been of interest to science teachers in Wisconsin schools, and it occurs to us that such home-study possibilities may be of interest to science teachers and others elsewhere who may wish to use the home-study method of keeping abreast with reference to the scientific developments with which university faculties are in intimate touch.

Increasingly, professional men and women find that a properly organized correspondence-study course provides a procedure by which one may keep effectively abreast with reference to contemporary advancement in certain specific areas for which university men have particular responsibility. A correspondence-study course as we conceive it and develop it, while formulated on a systematically organized plan, possesses flexibility that makes it adjustable to individual needs and requirements to a considerable degree, and thus provides considerable time-saving assistance to those who have the basic groundings.

This course as organized and conducted by Professor G. G. Town, Chairman of the Department of Chemistry in the University Extension Division, affords the teacher of science stimulation and suggestion, material and methods for the improvement of his own courses.

For further information write to: The Director, Department of Extension Teaching.

W. H. LIGHTY

UNIVERSITY OF WISCONSIN
MADISON, WISCONSIN

"CHLOROX" PROBLEM FOR CHEMISTRY STUDENTS

The problem outlined in this communication was recently assigned to my chemistry students. Although it proved a humdinger for most of them at this stage of their meager knowledge of chemistry, they evinced a real interest in it.

This problem is based on the actual experiment on chlorine performed by the students the previous week. They emptied the contents of their generators and their various bottles into suitable receptacles, and from this material the "Chlorox" was manufactured. This experiment was carried on where members of the class could inspect it at any time. The final product was given to the janitors, who made good use of it.

No account was taken of the manganous chloride that could be obtained as a by-product. Another problem for future use.

The problem is stated as follows:

A chemistry class of 60 prepares chlorine, each using 20 grams of MnO_2 and 125 cc. of hydrochloric acid for its preparation. The hydrochloric acid has a specific gravity of 1.18 and a concentration of 36%. Each student collects three 250-cc. bottles of Cl_2, and saturates 100 cc. of water with it (3 volumes of Cl_2 to 1 volume of water), and loses about 450 cc. of the gas. Following this the student saturates 125 cc. of a 10% NaOH solution (sp. gr. 1.11) with Cl_2, thereby preparing "Chlorox."

The MnO_2 costs \$0.25 per pound, the hydrochloric acid \$0.20 per pound, and the NaOH (solid) \$0.15 per pound. (453 g. per pound.)

The equations for the above reactions are:

$$MnO_2 + 4HCl = MnCl_2 + 2H_2O + Cl_2 \quad (1)$$
$$2NaOH + Cl_2 = NaClO + NaCl + H_2O \quad (2)$$

The following calculations are then assigned:

(*a*) The amount of MnO_2 used by the class.
(*b*) The grams of hydrochloric acid used by the class.
(*c*) The grams of HCl present in this amount of acid.
(*d*) The grams of HCl actually required for the above reaction.
(*e*) How much excess hydrogen chloride was used?
(*f*) How many liters, and how many grams of Cl_2 would be generated, using the MnO_2 as the basis of calculation?
(*g*) How much Cl_2 did the class use up to the point of the preparation of the "Chlorox"?
(*h*) How much Cl_2 was left with which to saturate the NaOH solution?
(*i*) How many grams of NaOH (solid) did the class use?

(*j*) How much Cl_2 would be required to saturate this much NaOH?
(*k*) How much additional MnO_2 will have to be supplied to generate sufficient Cl_2 to completely saturate the NaOH?
(*l*) Will any additional HCl have to be supplied? Why?
(*m*) How many grams of sodium hypochlorite (NaClO) will be made?
(*n*) What is the total cost of this problem?
(*o*) What cost should be charged to the preparation of the NaClO?
(*p*) At a concentration of 50 g. to a quart of water, how many quarts of "Chlorox" could be made?
(*q*) At $0.25 per quart what would this amount of "Chlorox" cost to buy?
(*r*) Compare the cost of "Chlorox" computed in (*q*) with the cost of production by the class as found in (*o*).

VERNON C. SHIPPEE

ORANGE UNION HIGH SCHOOL
ORANGE, CALIFORNIA

AVOGADRO AND EUCLID

Recent elementary chemistry textbooks tend to minimize theory and to introduce an enormous amount of descriptive matter. The rapid development and enlargement of chemistry demand that recent progress be described and that less attention be paid to older or more remote processes. The tendency has been to enlarge upon subjects such as alloy steels, electric furnace products, rayon, and organic chemistry, and to omit or merely mention the LeBlanc process, Nordhausen acid, gas mantles, and other old-time favorites. New topics are forcing their way into texts via newspaper headlines in ever-increasing numbers. In this rush to be up to the minute there may be a tendency to pay too little attention to the methods of scientific thought. Avogadro's principle furnishes an excellent example of this neglect. Some authors merely state the principle; others tantalize the student by stating that this is one of the most important principles in chemistry, but do not follow it through; and none of ten elementary texts selected at random carry this topic to a thorough conclusion. In fact, some students seem to gain the impression that Avogadro's *principle* was the administrator of his school.

I. The story of Avogadro's hypothesis can well be emphasized in the elementary course as an example of the development from a theory to a hypothesis and finally to a law. Avogadro had a perfectly definite set of phenomena to explain the regularity of behavior of gases, and he assumed the familiar explanation. Since this accorded with the work of Boyle, Charles, and Gay-Lussac, the theory was sufficiently valid to be a working hypothesis. We are told that later investigators used this hypothesis successfully and developed it. It is interesting to note that this hypothesis has now become dignified by the term "law."

II. The consequences of this theory are worth developing in the mind

of the elementary student. If we assume with Avogadro that equal volumes of gases under the same conditions of temperature and pressure contain the same number of molecules, several conclusions emanate.

1. Boyle's law, Charles' law, and Gay-Lussac's law of combining volumes are all satisfactorily explained—as Avogadro intended.

2. Equal volumes of two different gases (under the same conditions of measurement) have the same weight ratio as the weight ratio of the individual molecules of these gases.

3. If the formula of a gas is known, its density can be calculated by comparison with hydrogen. (Vapor density method: $\frac{\text{molecular weight}}{2} \times 0.09$).

4. A gram molecular weight of any gas occupies 22.4 liters.

5. Four common gases (O_2, N_2, H_2, Cl_2) have two atoms per molecule, and the number of atoms per molecule can be found for any other elementary gas which undergoes chemical change.

III. A new form for presenting the proof of two atoms per molecule is offered. This seems to "take" better than a page from the textbook.

Given: Avogadro's Hypothesis.

To Prove: The oxygen molecule has two atoms.

1. 2 volumes hydrogen + 1 volume oxygen ⟶ 2 volumes steam.	1. *Experimental measurements.*
2. Let one volume oxygen contain 1000 molecules, then 2000 mol. H + 1000 mol. O ⟶ 2000 mol. steam.	2. **Avogadro's hypothesis**—*Equal volumes of gases under same conditions of temperature and pressure have the same number of molecules.*
3. Water (steam) is composed of at least two sorts of atoms.	3. *Electrolysis of water experiment yields hydrogen and oxygen.*
4. Since each molecule of steam has at least 2 atoms, in 2000 molecules of steam there are at least 4000 atoms—at least 2000 atoms of O, and 2000 atoms of H.	4. **Law of Conservation of Matter**—*Matter cannot be created nor destroyed.*
5. 1000 mol. O contain at least 2000 atoms.	5. *From 2 and 4 above.*
6. ∴ One molecule of oxygen has at least 2 atoms.	6. *Dividing by 1000.*
Q. E. D.	

No claim for originality of this material is made. It is offered for whatever value it may be to teachers having difficulty carrying Avogadro's hypothesis to a conclusion with their students.

ELBERT C. WEAVER

BULKELEY HIGH SCHOOL
HARTFORD, CONNECTICUT

Chemical Digest

QUALITIES OF MERIT IN GOOD AND POOR TEACHERS

"Who is the *good* teacher?" A satisfactory answer to the question, thus briefly stated, is of greater importance than that of any other single problem in the entire field of education, according to Professor A. R. Mead,[1] of Ohio Wesleyan University, and he adds:

> The lives and welfare of millions of children are involved; the hopes, aspirations, and ideals of individual and social activities are at stake; and the tremendous financial loss involved in poor teaching gives all who reflect cause for considerable anxiety.

Since there is now existing no scientifically accurate criterion as to what constitutes good and bad teaching, Professor Mead has undertaken an investigation to determine how such a criterion may be established.

Lists of qualities of good and of poor teachers were assembled from school officials, from placement bureaus, and from teachers themselves, and other qualities were added as the investigation developed.

Data, which included the ranking of qualities of teachers in order of merit and which had been published by possibly a dozen different investigators, were examined critically and tabulated. Professor Mead finds the most important feature of this table in the almost total lack of agreement as to the relative merit of the qualities listed. For instance, Kratz ranks personal appearance second, while Davis places it tenth. Klapp ranks scholarship tenth, whereas Davis ranks it first.

J. R. Shannon in an investigation of "Personal and Social Qualities of High-School Teachers"[2] has listed seventy-three traits in the order of relative importance placing stimulative power first and personal appearance seventy-third in the list. It is interesting to note that he ranks punctuality twenty-third, facial expression thirty-seventh, health sixty-ninth, and intelligence *seventieth*.

A tabulation of causes of failure as ranked by three different authors shows slightly better agreement than was found in the ranking of the general qualities of teachers mentioned above, but even here the variation is marked. For example, Littler and Buellesfield each rank lack of scholarship fourth while Davis gives it the eleventh place.

A careful analysis of good and poor teaching was made by Barr.[3] He

[1] "Qualities of Merit in Good and Poor Teachers," *J. Educ. Research*, **20**, 239–59 (Nov., 1929).

[2] Terre Haute Normal School Press, **1928.**

[3] "Characteristic Differences of Good and Poor Teachers," Bloomington, Illinois, Public School Publishing Company, **1929.**

found the good teacher frequently using means of motivation, such as penalties, interest appeal of the subject matter, and experiences of the pupils themselves, thus arousing in the pupils a superior degree of interest, and he says further—

> In organization of subject matter, the poor type of teachers usually followed the textbook page for page, while the good teachers were quite likely to use some form of a topical outline. . . . In the use of various illustrative materials, the good teachers ranked higher, particularly with variety of materials. . . . Other features of superiority of good teachers were knowledge of subject matter, well-arranged procedure for examinations, pleasant attitude toward pupils, a sense of humor, and patience and enthusiasm. There were four major categories of weaknesses among poor teachers, as follows: (1) lack of mastery of subject; (2) inferior technic; (3) personal characteristics; and (4) inability to discipline. The chief sources of weaknesses were defective characteristics of personality, or personal qualities.

Professor Mead and his associates made a careful study of 130 teachers. A check-list was arranged having five groups of items; (1) items of technic; (2) items of scholarship; (3) items of professional interests; (4) items of community relations; (5) items of personal qualities. The investigators then secured interviews with persons who were experienced in supervising teachers and who were willing to give the information required concerning good and poor teachers on a number of the check-lists. Analyses of the qualities of a large number of teachers were made by the group of investigators themselves. Qualities that were found important among the several groups of teachers were tabulated and a comparison was made of the frequency of these qualities found in elementary, in high-school, in miscellaneous, and in poor teachers.

In the tabulation of the "qualities of technic, method, or teaching devices and types of teachers in which they are important factors" it is shown that among 40 elementary teachers, thirty-three qualities of technic were important; in 30 high-school teachers, twenty-seven types of technic were strong; in 30 miscellaneous teachers, forty-one types of technic were outstanding; and in 21 poor teachers only four types of technic were prominent. Those types notable for being used by poor teachers were recitation lesson, care of heating, care of lighting, and care of ventilation.

In the tabulation of qualities of scholarship it is shown that in 40 elementary teachers, sixteen phases of scholarship are important; in 30 high-school teachers ten phases of scholarship are prominent; and for the group of 21 poor teachers only two types of scholarship are important. These two are given as "information possessed by teacher about the local community" and "knowledge of rules of own school system."

The tabulation of "factors producing professional improvement" shows for the 40 elementary teachers that nine items are outstanding; among 30 miscellaneous teachers, twenty-three items are important; and for 21 poor

teachers, *three* items are essential. These three items are attendance at teachers' meetings, coöperative attitude toward supervision, and appropriate attitude toward other departments of work.

The tabulation of "personal qualities of teachers and types of teachers in which they are important" shows that among 40 elementary, 30 high-school, and 30 miscellaneous teachers sixty-two qualities are outstanding, whereas only eighteen qualities are outstanding among 21 poor teachers.

In summing up it may be noted that the poor teachers as compared with the other groups are deficient in the following; (*a*) phases of technic; (*b*) elements of scholarship useful to a teacher; (*c*) factors producing professional improvement; (*d*) relations of teachers to the community; and (*e*) personal qualities.

Among the personal qualities that are outstanding in the elementary, high-school, and miscellaneous teachers, but markedly lacking in poor teachers, the following items are found: courage, decision, enthusiasm, idealism, industry, initiative, intelligence, leadership, optimism, persistence, reliability, dignity, alertness, sense of humor, vivacity, sense of justice, power, self-reliance, promptness, faith, firmness, vitality, personal influence, self control, resourcefulness, and reverence.

The judgment of Professor Mead in interpreting the material gained in his investigation agrees with that of Professor Shannon in that:

> The failure of the weak teachers is more definitely attributable to certain traits than is the success of the strongest. Good teachers may possess many of the seventy-three traits but not noticeably so, any more than do many other teachers. The success of the strong teachers is due more to the fact that the traits were *not absent* than that they are present. There are many traits that we do not notice in a good teacher, but we miss them sorely in a bad teacher.

However, in comparing Shannon's findings with Mead's there are only 33 items in Shannon's list of 73 which were found important in Mead's.

The lack of agreement among the investigators leaves the problem still unsolved and Professor Mead advocates further work in the belief that ultimately there will be established an adequate description of the qualities of different classes of teachers and a system of acceptable rating of teachers' efficiency.

The reviewer suggests that the check-lists used by Professor Mead and the tables of qualities and skills presented in this article would prove invaluable not only in the hands of supervisors, but also of persons responsible for election of teachers, thus introducing a scientific basis for the choice of teachers in place of the hit-or-miss methods now in vogue. Furthermore, the desirable qualities should be emphasized in the training of teachers since many of them are of the type that may be acquired.

R. M. P.

THE POPULARIZATION OF SCIENCE[1]

The scientific progress of a country is dependent on the appreciation of science by an interested public as well as on the support and encouragement of wealthy men. Many of the greatest strides have been made, it is true, through the patronage of philanthropists. But a comprehensive, sound body of science can no more be built without the credence and sympathy and even the practical assistance of a large part of the population than could the cathedral of Chartres have been erected, unaided, by the nobles of Beauce. The best science, like the greatest art, belongs to the people and must express their spirit.

In America we are witnessing today a nation-wide flowering of interest in science that is without precedent. A number of startling disclosures, such as radioactivity, the automobile, the airplane, the radio, the X-ray—all of them the results of scientific research—have forcibly impressed on every one the concrete significance of science to his own welfare. The scientist must nourish this new-born interest. The medium through which he must work to this end is primarily the press. The demand for scientific information exists; he does not have to create it. His responsibility and opportunity consist in providing accurate material in sufficient quantities and of proper quality.

In this country the literary popularization of science on a large scale is roughly coeval with the present century. Previously popular lectures were the favorite means. Among the names which shine brightest in both fields is that of Robert Kennedy Duncan (1868–1914), whose efforts to promote coöperation between science and industry found expression in the establishment of the industrial fellowship system. More lately the foremost figure has been Edwin E. Slosson, whose recent death was such a great loss to the scientific professions. Both men were remarkable for their power of translating technical achievements into simple, lucid, emphatic, correct language. The success of Slosson's *Science Service* is well known; this organization is now one of our chief agencies for the popular dissemination of scientific facts.

The use of slang has been proposed by J. H. Collins[2] as a device, well in harmony with the tempo of the day, for calling attention to the results of scientific research. This suggestion is worthy of consideration; that we shall see it in operation cannot be doubted, and, indeed, a trend in this direction can already be observed.

We cannot but feel that Collins has taken a somewhat extreme stand in advocating the wholesale abandonment of the classics and of the standards of good English. Slang may well have its place in popularization, but by its very nature it is of only fleeting appeal. Even newspapers and magazines that make a fetish of the sensational do not go to marked lengths in the use of inelegant diction, except in their comic sections. The stylistic excellence of Collins' own writing and of the two technical works he cites as examples of good composition illustrates the fact that, though his ideas might appear to be radical, he does not intend that he should be taken too literally. Science, a dignified branch of learning, must not be treated with a levity that would invite disrespect. The difficulty of imparting popular scientific knowledge lies in the obscure and monotonous literary style of the scientist and not in a demand for slangy literature.

The newspapers that use science articles are not inclined to overlook the great educational influence they exert. The editors of such papers do not shirk their duty as educators by using coarse expressions. "Rubber-stamp" writing and "journalese" are disappearing. Some of the most successful American papers are successful because they have remained steadfast in their high educational policies and have sought constantly to bring their readers up to the same level.

---

[1] By W. L. Hamor and L. W. Bass, *Science*, **70**, 632–4 (Dec. 27, 1929).

[2] *Chem. Met. Eng.*, **36**, 619 (1929).

In discussing the composition of popular articles, let us first examine the purely technical paper, which serves as the foundation. This document, enigma though it may be to the uninitiated, in general possesses the very important quality of being logical in arrangement. The usual order of treatment—historical introduction, theoretical background, experimental part, discussion of results and conclusions—is symbolic of the scientific method and of the savant's habits of thinking. There are, however, a multiplicity of technical polysyllables, a stereotyped phraseology, a tendency toward errors in grammar and a circuitous method of expression. The last difficulty, possibly due to the innate conservatism of the scientist, has been referred to as the use of the alternating current instead of the direct in conveying the thought. As the article must be shortened considerably in translation into every-day English, these faults should be corrected during the process. The important point to be noted is that the arrangement of the subject matter corresponds not only to good newspaper usage but also to good literary style.

Probably the most difficult part of popularization is the preparation of the summary "lead," the introductory paragraph that attracts the attention of the reader and arouses his interest by linking the subject matter of the article with his personal experience. Whether or not this introduction answers all the questions of the "old-time" news lead—who, what, where, when, and why—it should always sound the keynote of the information to be conveyed. Unfortunately, in the hands of those untrained in science, this introduction is likely to be poorly chosen, and to emphasize some point that is merely speculative or at best of minor importance. This probability has led to an unreasonable dread of all gentlemen of the press by many scientific men. Aggravation of this fear is caused by the general newspaper practice of having headlines composed by men other than the writers of the copy; a worthy article, conservative and accurate, may have its effect ruined by a too enthusiastic headline writer. On the other hand, the scientist, inexperienced in popular psychology, is inclined to choose a lead uninteresting to the reading public. E. E. Free and Morris Fishbein, happy combinations of scientist and popular writer, never seem to have difficulty in finding good leads.

Before leaving the discussion of the introduction we wish to add that the lead is often written first. Its preparation should always be deferred, however, until after the remainder of the article is ready—a practice that will result in economy in time and in a more interesting introduction. Still another advantage of this procedure, at least from the scientist's point of view, lies in the fact that the writer will then base his lead upon the facts instead of shaping the facts to fit his lead.

The writing of the body of the translation is not difficult to the competent. As we have already said, the arrangement of the original technical paper is usually logical, and the experienced writer chooses his material from the various sections in the order in which they occur. From time to time he stresses the reader's interest by tying to his statements references to matters of common experience.

A knowledge of grammar may well be assumed for the popularizer, but is equally important for the scientific man, particularly if he aspires to become a non-technical writer. How many important discoveries have been overlooked by journalists because they were described originally in ambiguous and unemphatic language! Sometimes this defect is overcome through the efforts of another writer who "interprets"—by rewriting in more understandable form, that is, in more straightforward English—his predecessor's work.

Rhetoric, or artistic discourse, plays a vital rôle in reconstructing technical papers. How else can the heavy style of the scientist be translated into forceful, gracious prose if not through the application of the principles of composition? Unfortunately, the scientist rarely realizes that there are rhetorical methods for securing force, rapidity, emphasis,

life, and the other desirable qualities of good writing. It may even be that more practiced writers also are somewhat ignorant on this subject.

Wide reading of the classics and of the best modern writing is a necessary supplement to a study of grammar and rhetoric. From such reading the budding writer derives not only a feeling for the best in literary style, but also the knowledge of human nature essential to a broad discussion of contemporary events and trends. He is then able to integrate in his compositions the experience of centuries of history. The benefits of extensive reading are apparent in the works of the masters of scientific literature; some of those writings deserve high rank among the classics of all time.

A good translation of a scientific paper is a work of art. It is at once elevated and popular; it manifests to all that which is recondite. Science describes her accomplishments abstractly in technical language. Art reveals these facts, not aridly, but concretely, addressing itself not only to the understanding, but still more to the sentiments of the ordinary man. Like every artist, every man who writes successfully must catch the spirit of the ensemble before him. He must therefore have interested perception and enthusiasm for things scientific.

The treatment accorded scientific progress in magazine articles is generally measured and dignified, but newspaper technic is occasionally open to question. We do not mean to disparage in any way the ability and sincerity of the news reporter, but we believe it sometimes happens that his actuating enthusiasm in his object—the emphasis of the sensational and novel—leads him to exaggerate and even wrest partly out of shape, although without real intent, the main facts of technical discoveries. On the other hand, the editorial writer, skilled in sublimating news, adept at crystallizing events, has developed traits that peculiarly qualify him for the popularization of science. The broad field that he may cover, the greater time that he can devote to writing and the disinterested point of view from which he writes all tend to result in articles of accuracy, dignity, and authority that are gratifying to the scientist. The feature or special writer, who is in some respects comparable with the editorial writer, may be equally successful as a popularizer of science. Finally, the usual excellence of syndicated articles should not be overlooked; the time assigned for the preparation of such material generally makes it possible for the author to obtain the constructive criticism of the scientist whose work is discussed.

A happy condition seldom realized is the literary collaboration between writer and man of science. Every newspaper interested in scientific news should have reliable sources of information who may be consulted for authoritative criticism. The statement is often made that any good writer can make of a technical paper an excellent popular article. This mistaken conception ignores the obscurity often found in scientific writing and the nice balance required by different phases of the subject. An unhappy juxtaposition of ideas, an unthinking distribution of emphasis, can do much to void the accuracy of the translation. Even the popular writer with a broad knowledge of science will not regret submitting to the judgment of the technical specialist.

HUNTER COLLEGE JOURNALISM CLUB

At what age does education seem most vital to adults? According to statistics recently gathered in the Hunter College Evening Session by Professor A. Broderick Cohen, Director, people in their twenties who study at night comprise a group three times as large as any other. There are 4129 adults in this group, which is more than one half of the 9879 registered as students. The smallest group numbers 11 earnest students in their sixties, a noticeable decrease in registration taking place after the age of forty.

More than 1500 students give their ages between 20–39; 500 between 40–49; 123 between 50–59; and 1701 as less than 21 years of age.

Practically every occupation in New York City is represented among the students, announced Professor Cohen. The most crowded is teaching, which has a total of 3729. Secretarial and clerical workers number 1139, and bookkeepers, 470. There are 386 who give their occupations as students. It is interesting to note, also, that 166 housewives regularly attend school at night. Among the other students are included actresses, artists, blacksmiths, builders, carpenters, cashiers, dancers, designers, draftsmen, editors, electricians, engineers, factory hands, laboratory assistants, milliners, nurses, sales clerks, and lawyers.

The most popular courses in the Hunter Evening Session are Methods and Education, with an attendance of 4096, a condition due to the new "mental alertness" requirement of the Board of Education, whereby teachers must continue their studies in order to qualify for salary increase. English, with a student enrolment of 2059, is second in popularity.

Languages are favorite studies, having the following enrolments: French, 899; German, 853; Italian, 250; Spanish, 207; and Classics, 165.

Cultural courses are all well attended: art, 538; Speech and Dramatics, 461; Music, 434; totaling 1433.

The sciences have a registration of 874; Mathematics, 299; Geology, 151; Chemistry, 126; Biological Sciences, 106; Physiology, 90; and Physics, 42.

In the History and Social Science Department there are 781 students, and in the Department of Physical Education, 638.

A 31% increase over the preceding semester's enrolment, a total registration of 9879, as compared with the 6850 students of last term, has been noticeable, says Professor Cohen, in view of the decreased enrolment elsewhere. A corresponding increase on the faculty brings the total to 340 instructors. The work of the Evening Session is being carried on in 26 centers of instruction throughout the 5 boroughs of New York City.

The student distribution according to boroughs is as follows: Brooklyn, 3905; Manhattan, 2026; Bronx, 1928; Queens, 1261, and Richmond, 297. Students coming from outside New York City total 462.

For Your Radiator's Sake! From Seidell's "Solubilities of Inorganic and Organic Compounds," vol. 2, is obtained the following table on the freezing points of mixtures of denatured alcohol and water. It may be of some value to you during the winter months, and a look here in time may save nine leaks in the radiator.

Per cent by volume of alcohol in mixture	Freezing Point °F.	Freezing Point °C.
5	27.0	−2.8
10	24.8	−4.0
15	21.2	−6.0
20	16.7	−8.5
25	11.3	−11.5
30	5.4	−14.8
35	−0.9	−18.3
40	−7.8	−22.1
45	−16.4	−26.9
50	−24.0	−31.1

—*The Accelerator*

ABSTRACTS

APPARATUS, LABORATORY PRACTICE, AND DEMONSTRATIONS

The Kinetics of the Reaction between Formaldehyde with Bisulfite and Sulfite. Demonstration Experiment. C. WAGNER. *Ber.*, **62B**, 2874–7(1929).—The reaction between $NaHSO_3$ and Na_2SO_3 with CH_2O takes place in two successive steps:

$$CH_2O + H\bar{S}O_3 \longrightarrow CH_2OH\bar{S}O_3 \quad (1)$$

$$CH_2O + S\bar{\bar{O}}_3 + H_2O \longrightarrow CH_2OH\bar{S}O_3 + O\bar{H} \quad (2)$$

This makes it possible to determine the time for a given conversion by adding a suitable indicator (thymol phthalein) which turns color over a suitable range, pH = 9.3–10.5. The reaction was found to be bimolecular, but owing to a side reaction

$$O\bar{H} + H\bar{S}O_3 \longrightarrow S\bar{\bar{O}}_3 + H_2O \quad (3)$$

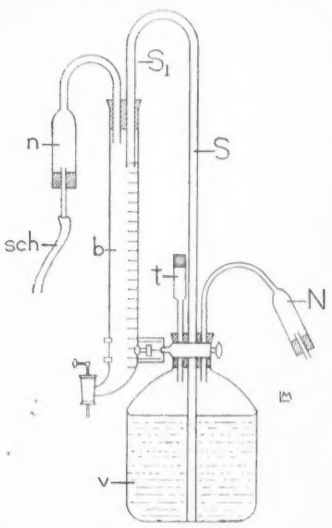
the reaction time decreases with increasing $S\bar{\bar{O}}_3$ concentrations. The reaction velocity equation was found to be

$$\frac{d[CH_2(OH)S\bar{O}_3]}{dt} = k_1(CH_2O)(H\bar{S}O_3) + k_2(CH_2O)(S\bar{\bar{O}}_3)$$

in which $k_1 = 2.8$ (liter/mol. sec.) and $k_2 = 0.14$ (liter/mol. sec.). The speed was not materially changed in a 20% alcoholic solution. The reaction is very suitable for demonstration purposes, using concentrations of $CH_2O = 0.1$; $NaHSO_3 = 0.05$; $Na_2SO_3 = 0.08$ and 1 cc. of 0.04% alcoholic thymol phthalein for every 100 cc. solution. By keeping the ratios of concentrations constant but changing their absolute values, the time for the color change to be noted is inversely proportional to the initial values of the concentrations. H. C. D.

Demonstration Experiment on Oxidation-Reduction. See "Teaching Oxidation and Reduction," A. HAUT, under **Teaching Objectives, Methods, and Suggestions; Curricula,** page 686.

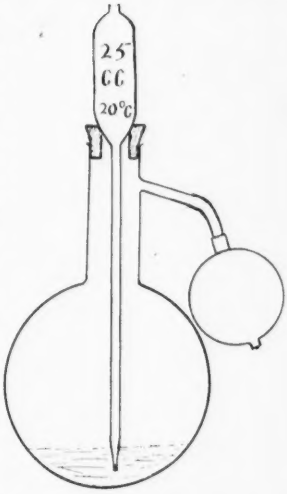
An Automatic Buret. J. FISCH. *Chem.-Ztg.*, **53**, 799 (Oct. 12, 1929).—A number of automatic burets are already available. The one given here can be assembled easily from ordinary pieces of apparatus. The stock bottle *v* is supplied with a 3-hole rubber stopper; *t* is a funnel made from a test tube which is closed tightly with a stopper after *v* has been filled. The U-shape bent glass tubing *S* (length about 115 cm.; inside diameter 3 mm.) is fitted through the 3-hole stopper in *v* and a 2-hole stopper in the buret *b*. The shorter branch S_1 should end about 2 mm. below the zero point. A drying tube *N* filled with soda lime and provided with a 1-hole rubber stopper, a short piece of glass tubing, and rubber tubing *sch* is also attached to the buret. Another drying tube filled with soda lime and provided with a 1-hole rubber stopper and a piece of glass tubing is fitted through the third hole of the stopper in *v*. To manipulate the buret fill *b* by suction through the rubber tubing *sch*. Any excess flows back automatically. The zero point can be adjusted easily once for all. L. S.



Crucible with Handle. KÖNIG. *Chem.-Ztg.*, **88**, 851 (Nov. 2, 1929).—When an ordinary crucible is picked up with tongs there is always the danger that some of the contents inside of the crucible adheres to the tong. The handle does away with the unnecessary loss of material and possible contamination. The crucible with handle is manufactured in porcelain, quartz, metal, etc., by W. Feddeler, Essen, Wächterstr. 39. L. S.

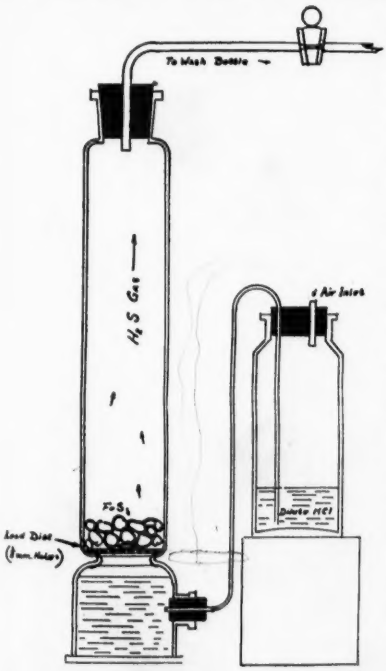
Automatic Pipet Filler. H. JAMES. *Chem.-Analyst*, **19**,

20 (Jan., 1930).—Distilling flasks with broken delivery tubes can be utilized for this purpose. The damaged side arm is fire polished and an atomizer bulb attached. The neck of the flask is cut to a length suitable for the pipet. The neck is fitted with an old flexible rubber stopper with a hole about two-thirds that of the pipet bulb. The obnoxious or poisonous liquid to be pipetted is placed in the flask, the pipet inserted, pressed against the rubber stopper, and pressure introduced by means of the bulb. If a distilling flask is not available, a wide-mouthed bottle may be fitted with a two-hole stopper, one to fit the pipet, and the other for a glass tube, bent at a 45-degree angle to which the atomizer bulb is attached. D. C. L.

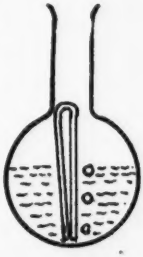


A Continuous Flow Non-Splash Wash Bottle. A. R. GOLDFARB. *Chem.-Analyst*, **18**, 20 (Nov., 1929).—This consists of the regular type wash bottle except that through a third hole in the stopper a short piece of glass tubing is passed, on which the finger must be placed when the bottle is in use. The tube through which one blows has a Bunsen valve, made of a triply split rubber policeman, on the other end. By constriction of a portion of the delivery tube near the end where the water enters to about half of its original bore, dripping is avoided. D. C. L.

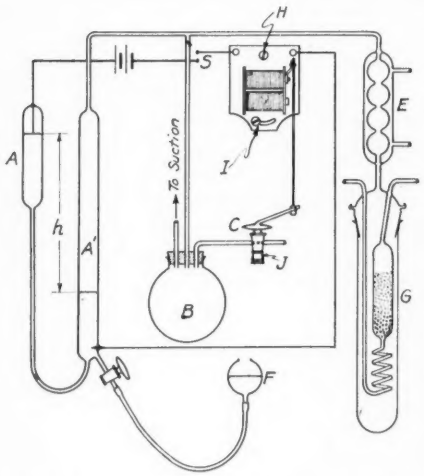
An Improved Hydrogen Sulfide Generator. B. J. EFFINGER. *Chem.-Analyst*, **19**, 22 (Jan. 1930).—The generator consists of a calcium chloride drying chamber, with the FeS supported on a lead plate, perforated with holes about half a mm. in diameter to prevent the fine FeS from falling through into the acid. The gas escapes at the top. The acid reservoir is a small wide-mouthed bottle from which the acid is siphoned. D. C. L.



A General Method for Prevention of Flask Bumping during Boiling. A. B. KNOEBEL. *Chem.-Analyst*, **19**, 20 (Jan., 1930).—A glass tube about 5 mm. in diameter is bent sharply until both ends touch. The two ends are broken evenly and fire polished. The tube, ends downward, is lowered into the flask. Boiling proceeds quietly and steadily from the points where the tube ends make contact with the bottom of the flask. Use in several thousand distillations shows that it always works successfully. D. C. L.



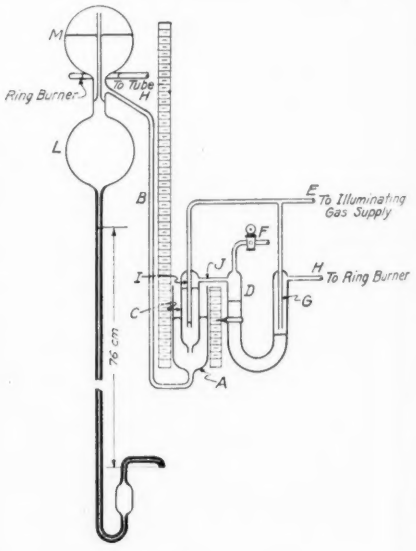
Graduate Cylinder Protector. W. A. ALBRECHT. *Chem.-Analyst*, **19**, 21 (Jan., 1930).—See "A Protector for Graduated Cylinders," by the same author in THIS JOURNAL, **6**, 336 (Feb., 1929). D. C. L.



A Simple Laboratory Vacuum Regulator. W. E. KUENTZEL. *J. Am. Chem. Soc.*, **51,** 3347–9 (Nov., 1929).—For the maintenance of constant temperature over a range from room temperature to red heat, frequent use is made of a vapor bath with a liquid boiling under some reduced fixed pressure. Numerous devices have been suggested for maintaining these reduced pressures over long time intervals and the present design is a simplification of these. It consists of an ordinary door bell buzzer in which the operating current, broken by the change of level in a mercury manometer, is applied directly to the magnet coils of the buzzer so that it acts as a relay. The ringer arm is lengthened and operates a stopcock which admits air to a large reservoir, connected to any convenient pumping arrangement, whenever the pressure in this reservoir drops below the desired value previously adjusted in the manometer, and which closes this stopcock whenever the pressure becomes greater than the desired value. The system to be maintained at constant pressure is connected to this same reservoir.

BYCK

Automatic Cut-Off Device for a Gas-Fired Laboratory Mercury Still. W. E. KUENTZEL. *J. Am. Chem. Soc.*, **51,** 3349–51 (Nov., 1929).—A device is described which automatically cuts off the gas supply from the burner operating the common laboratory mercury still, when the mercury level in the still falls below a certain level, thus preventing damaging of the still by heating with insufficient mercury within it. The still is of the usual type. The distance between the mercury levels in *M* and in *A* is the prevailing barometric height. As the level in *M* falls due to distillation of mercury, *A* also falls. The level in *C* falls until the seal over the gas tube is broken, gas flows into the arm *D* through *J*. *D* at the start is slightly evacuated to uncover the main gas inlet *G*, and now, when gas flows into it, the mercury levels in *D* readjust themselves and cut off the gas supply.



BYCK

Wax Bottle Support. G. W. CORRIE. *Chem.-Analyst*, **18,** 18 (Nov., 1929).—In hot summer months wax bottles containing HF become soft and plastic and are dangerous to handle. This danger is overcome by placing the wax bottle in a metal can of the proper size, thus forming a metal shield around it. If the metal can is too large the intervening gap can be filled with wax or some other material.

D. C. L.

Emulsifier. G. L. HOCKENYOS. *Chem.-Analyst*, **18,** 22 (Nov., 1929).—Small quantities of emulsion can be conveniently prepared by placing the substances to be emulsified in a test tube, not over half full, and plunging back and forth a test tube brush that just about fills the tube. By being forced through the space between the bristles, it is thoroughly agitated and a good emulsion results. D. C. L.

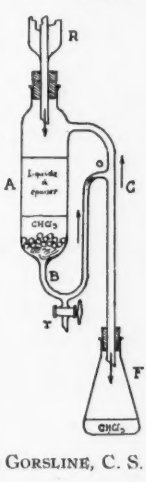
Stabilizing Sodium Thiosulfate Solutions. H. W. JONES. *Chem.-Analyst*, **18,** 5 (Nov., 1929).—The variation of the copper standard on a sodium thiosulfate solution may be practically eliminated by the addition of 2 grams NaOH per liter of solution. D. C. L.

Anhydrone, $Mg(ClO_4)_2$. A Perfect Substitute for P_2O_5 to Be Used as a Drying Agent. G. F. SMITH. *Chem.-Analyst*, **18,** 6 (Nov., 1929).—P_2O_5 is a very thorough drying agent. Its undesirable properties are high cost, disagreeable to handle, prepared only as a powder, cannot be regenerated economically, cannot be used with many substances on account of its acid properties, absorbing power about 10%. "Formerly anhydrous $Mg(ClO_4)_2$ could not be prepared in granular form. For this reason the trihydrate, sold in granular form under the name Dehydrite, met the demand as a substitute for P_2O_5." Anhydrone eliminates the objections to P_2O_5 mentioned above. It is granular, extremely porous, water soluble and stable to 250°C. It is a neutral reagent, easily handled, and can be regenerated under proper conditions. It is a reversible absorbent for ammonia. There is no diminution of water vapor absorption efficiency at moderately elevated temperatures. Cost is less than that of P_2O_5 per pound of water absorbed. D. C. L.

Glass and Glass Making Materials. C. S. CHAFFEE. *Hexagon*, **3,** 141–5 (Dec., 1929).—A brief summary of some of the properties of glass essential to fabrication of bottles and jars by machine, and the effect of various ingredients in obtaining these properties is given. It is indicated that glass making is at best a compromise where, though it is known which ingredients give various properties, only limited amounts may be used without affecting adversely other properties. A test is given of eight properties desirable in glass. BYCK

Adaptation of the Diphenylcarbazide Test for Mercury to the Scheme of Qualitative Analysis. A. W. SCOTT. *J. Am. Chem. Soc.*, **51,** 3351–2 (Nov., 1929).—The diphenylcarbazide test for mercury is very delicate, detecting 0.005 mg. per 2 cc. but its use so far has been restricted to practically neutral solutions. However, in the confirmation of mercury both in Group I and II, the solutions are decidedly acid. By the addition of an excess of sodium carbonate (neither sodium acetate nor sodium bicarbonate can be substituted) to such solutions, the presence of considerably less than 0.1 mg. mercury per cc. can be detected readily. A procedure found successful for this determination is given. BYCK

Chemical Analysis Facilitated by Laboratory Appliances: Applications to the Determination of Theobromine and to the Testing of Cola Preparations. A Continuous Extractor. JALADE. *Ann. fals.*, **22,** 396–405 (1929); *Chem. Abstr.*, **23,** 5272 (Nov. 10, 1929).—The "perforator" illustrated herewith is suitable for continuous extraction with a small volume of a solvent (*e. g.*, $CHCl_3$) heavier than the solution to be extracted, the extracted substance being weighed directly in the flask after evaporation of the solvent. The tube *Bo* should be of small bore to prevent siphoning. Its advantages for the determination of theobromine in cacao and for the analysis of cola nuts and preparations are discussed. [*Editor's Note:* See "A Continuous Extractor for Solids," J. H. GARDNER AND E. B. W. KERONE, THIS JOURNAL, **7,** 593 (Mar., 1930).] C. E. M.



Standardized Ground-In Connections. J. FRIEDRICHS. *Chem. Fabrik*, **1,** 275 (1928); **2,** 5 (1929).—This article, which is well illustrated (58 cuts) and comprehensive in scope, is published in booklet form by GREINER & FRIEDRICHS, G. m. b. H., Stützerbach in Thüringen, Germany. M. W. G.

Note on Preparation of Collodion Bags. C. S. SHOUP. *Science*, **70,** 430 (Nov. 1, 1929).—For those interested in the use of collodion bags for dialysis, classroom experiments in physiology, etc., where uniformity and ease of preparation are important, attention is called to two papers doubtlessly overlooked at this late date: HARRIS, N. M., *Centralb. f. Bak. und Par.*, I, **32,** 74 (1902) and GORSLINE, C. S. *Science*, p. 375, March 7, 1902.

Both authors describe the formation of a collodion bag on the outside of large gelatin capsules held by heated glass tubing thrust into one end, over which the collodion may form a narrow neck to the bag of perfect uniformity and free from flaws to any desired thickness. Warm water allowed to flow into the capsule after drying of the outer collodion coating dissolves the interior gelatin wall, leaving the perfect collodion bag. The glass tubing may be left in place or removed, as desired. Harris gives a brief history of previous attempts to make such sacs on the ends of glass tubing. C. E. M.

Cleaning Volumetric Glassware. E. A. VUILLEUMIER. *Ind. Eng. Chem., News Ed.*, **7**, 3 (Dec. 10, 1929).—"The standard bichromate 'cleaning mixture' of the analytical laboratory has long since deserved to be displaced. It is dangerous, destructive, and inefficient.

"Trisodium phosphate as a possible laboratory detergent has been investigated exhaustively by O. A. James, and has much to recommend it. A 15 per cent solution, heated to about 70°C. has been used for more than a year for cleaning burets and other volumetric glassware with very satisfactory results." C. E. M.

A New Freezing Mixture. F. NOACK. *Ind. Eng. Chem.*, **21**, 1001 (Nov., 1929).—The freezing mixture consisting of 1 part each of ammonium nitrate, sodium carbonate, and water produced a temperature drop of 31 degrees, but is rather expensive. A German patent granted to W. Kasch describes a mixture producing the same lowering at one-fourth the cost. It consists of 100 parts NH_4Cl, 150 parts Na_2CO_3 and 300 parts water. D. C. L.

Blocking-Out Undesirable Backgrounds in Photographs. A. MANN. *Science*, **70**, 408 (Oct. 25, 1929).—A method is suggested to those who use photomicrographs for illustration of blocking-out the backgrounds of their negatives by means of cellophane sheets. The ruby red cellophane is absolutely non-actinic and so extremely thin that it permits perfect contact between negative and printing paper. The sheets, $35 \times 40''$, are cut up into pieces corresponding in size to the negatives.

"One of these is laid on the film side of the negative and the outline of the photo is traced on the cellophane with pen and ink. Any error in the ink outline can be corrected by drawing a new line without bothering to remove the inaccurate one, as the non-actinic cellophane makes such lines invisible in the print. The true outline is then cut out by means of dissecting scissors or a sharp scalpel or a very finely pointed needle. It is best done over a piece of white blotting paper. The opening is then placed over the photo and the two outlines are accurately adjusted. A minute drop of thick styrax, such as is used in microscopic amounts, will fasten the four corners of the cellophane film to the face of the negative.

"By this method perfect accuracy in blocking-out backgrounds is secured in far less time than by the common one of painting out with opaque red or India ink. In the case of diatom photos, the improvement in the finished prints is very great, for on account of their translucence unblocked backgrounds are usually dense and greatly detract from the sharpness of the photo. The almost infinite variety in diatom outlines also makes blocking-out by the old method a difficult and slow task.

"It should be added that objects with circular outlines, a form common among diatoms, can be most easily outlined by measuring the diameter of the circle and cutting out an opening with a pair of compasses, the tip of one leg being sharpened so as to cut through the cellophane film. Obviously, also, this material is ideal for mats around pictures where complete blocking-out is not desired.

"Negatives so prepared can be stored without any appreciable loss of space." C. E. M.

The Determination of Gelatin in Dilute Solutions. J. G. KANE AND H. E. WATSON. *Chem. & Ind.*, **48**, 335T-6T (Nov. 1, 1929).—The authors make use of refractive index for the rapid and accurate determination of the concentrations of dilute aqueous solutions of gelatin. A table showing the change of refractive index with change in concentration is given. The study was made at 21° and at 29°. E. R. W.

Measuring the Millionth of a Centigrade Degree to Test Modern Scientific Theories. F. T. GUCKER, JR. *Sch. Sci. Math.*, **29**, 923–31 (Dec., 1929).—Author describes construction, operation, and sensitivity of thermometers of the expansion, resistance, and thermo-electric types. A highly sensitive multiple thermal instrument is diagrammed and described, and its use in research illustrated by several examples. B. H. B.

TEACHING OBJECTIVES, METHODS, AND SUGGESTIONS; CURRICULA

Teaching Oxidation and Reduction. A. HAUT. *Sch. Sci. Math.*, **29**, 962–8 (Dec., 1929).—Author advocates use of electron theory of structure of matter in high-school

courses in chemistry, as basis for explanation of metallic or non-metallic nature of atom, valence, chemical activity, and oxidation and reduction. A series of questions and answers and a demonstration experiment are included. B. H. B.

Chemical Engineering Education. T. K. SHERWOOD. *Rep. New Eng. Assoc. Chem. Teachers*, **31**, 39–42 (Nov., 1929).—The most important of the so-called unit processes of chemical engineering are: flow of heat, flow of fluids, distillation, evaporation, drying, filtration, crushing and grinding, absorption, and combustion, although others may be included. It is the quantitative study of these processes which constitutes the professional course in chemical engineering. O. C.

New Elementary Science Course Explains Radio, Television, and Talkies. ANON. *School*, **11**, 173 (Nov. 14, 1929).—A new course in science to be introduced in the New York City schools in February, 1930, will explain the "how" of many of the modern comforts of life which are rapidly becoming "common." The course will present a cross-section of life in the biggest city of the modern age, and will make the pupil acquainted with the outstanding features of the great scientific age in which we are living. "Children are hungry for the knowledge that science has to give them;" they want to know about the things that they see all about them. They need this information to help them to adjust themselves intelligently to our rapidly changing world, and it is up to the schools to give it to them.

"Two forty-minute periods are to be allotted each week for science in schools on a five-hour teaching schedule," the first being a lecture-demonstration-discussion lesson. The second period may be spent as the teacher thinks best; this may be: (*a*) "completing the presentation of an unfinished unit topic, (*b*) drilling on, or reviewing units already taught; (*c*) planning pupil activities described in the introduction; (*d*) engaging in optional supplementary activities suggested for each unit topic." H. T. B.

The Individual Plan of Graduate Study at the University of Iowa. W. F. LOEHWING. *Sch. & Soc.*, **30**, 743–5 (Nov. 30, 1929).—Similar to the method of study employed in many European universities, though broader in its scope, is this new and recently adopted optional plan at the Univ. of Iowa, wherein routine undergraduate methods are discarded and an independent rate of advancement established. K. S. H.

KEEPING UP WITH CHEMISTRY

The Fundamental Atomic Quantities and Atomic Weight. D. ROLLER. *Sch., Sci. Math.*, **29**, 961–2 (Dec., 1929).—A brief discussion of the associated fundamental quantities; atomic number, mass number, and atomic mass. Author points out that atomic weight is more properly combining mass, also that the arbitrary value of 16 assigned to oxygen as standard for comparison is based on the assumption that oxygen has no isotopes—which it now appears is not true. B. H. B.

An Isotope of Oxygen, Mass 17, in the Earth's Atmosphere. W. F. GIAQUE AND H. L. JOHNSTON. *J. Am. Chem. Soc.*, **51**, 3528–34 (Dec., 1929).—From an analysis of atmospheric absorption spectra photographed at Mt. Wilson Observatory by H. D. Babcock, the authors who previously showed the presence of an oxygen isotope of atomic weight 18, present additional evidence for the existence in the earth's atmosphere of an isotope of atomic weight 17. This isotope has been reported previously by several investigators studying collisions between alpha particles and nitrogen nuclei. Estimates on the maximum amount of these isotopes in the atmosphere, made from intensity measurements of Babcock give: oxygen 18 present not more than 1 part in 1250 and oxygen 17 not more than one part in 10,000. BYCK

Effect of Neutral Salts on H-Ion Concentration. F. R. BUTLER. *Rep. New Eng. Assoc. Chem. Teachers*, **31**, 51–4 (Mar., 1929).—There is a correlation between the ability of salts to increase the H-ion concentration of acids and the viscosities of solutions of the salts. When a neutral salt of a monobasic acid is added to an acid solution the ions of the salt are hydrated to such an extent that the H-ion concentration is greatly increased even in cases where the mass action law would predict a decrease. O. C.

Some New Aspects of the Electrochemical Oxidation of Organic and Inorganic Compounds. Part I. The Electrochemical Oxidation of Aromatic Hydrocarbons. Part II. The Electrochemical Preparation of Vanillin, Saccharin, and Dyestuffs. F. FICHTER. *Chem. & Ind.*, **48**, 325T–33T (Nov. 1, 1929).—Aromatic hydrocarbons are readily attacked and disintegrated by anodic oxygen, thus hindering the commercial use of this method. The value of the training offered by work in organic electrochemistry warrants interest in this subject even if the commercial applications are rather limited in number. E. R. W.

A Theory of Liquid Film Formation. C. W. FOULK. *Ind. Eng. Chem.*, **21**, 815 (Sept., 1929).—In evaporation and distillation, foam is objectionable, while in soap

suds, flotation of ores, and beer a stable foam is desirable. The general facts about foams are: (1) pure liquids do not foam; (2) some impurity must be present, dispersed whether molecularly or colloidally; (3) it matters not whether the added substance has a greater or less concentration in the surface layer than in main body of liquid; (4) certain substances destroy or inhibit foam formation by either positively or negatively charged substances. This leads to the conclusion that it is unlikely that a correlation can be found between foaminess of a liquid and any of its chemical constants. This is really in harmony with the theory here advanced which ties it up with the general behavior of dissolved matter in liquid surfaces.

Films of pure liquids do not form, since there is no surface layer of different composition to resist the forces tending to produce homogeneity, as is the case in solutions. Liquid films are always formed by the approach toward each other of two surfaces, as a bubble rising to the surface. Due to difference in concentration in the surface layer, the mechanical force tending to bring them together meets with resistance when the liquid layer becomes quite thin, thus forming a film. Two bubbles brought together in a pure liquid will coalesce, while in a solution they will be separated by a thin film.

D. C. L.

Recent Reactions between Theory and Experiment. The Raman Effect: The Constitution of Hydrogen Gas. E. RUTHERFORD. *Nature*, **124,** 878–80 (Dec. 7, 1929).—This is from a presidential address delivered at the Anniversary Meeting of the Royal Society on November 30, 1929. F. B. D.

Chemicals in the Movies. G. E. MATTHEWS. *Chem. Markets*, **25,** 365–8 (Oct., 1929).—An account of the chemistry involved in the manufacture of photographic film. H. H. K.

Chemical Statistics. S. J. COOK. *Chem. Markets*, **25,** 383–5 (Oct., 1929).—The value of statistical research to the manufacturer is discussed. H. H. K.

Mobile Helium Repurification Plant. *Ind. Eng. Chem., News Ed.*, **7,** 1 (Dec. 10, 1929).—Description with picture of a mobile helium repurification plant recently designed and constructed by the Helium Co. of Louisville, Ky. M. W. G.

Bingham Canyon's Great Copper Camp. Part 2. R. G. SKERRETT. *Compressed Air Mag.*, **34,** 2975–9 (Dec., 1929).—This mine, the largest open pit copper mine in the world, is worked with profit although the ore is of very low grade. Illustrations and descriptions tell of the modern mining methods which make this possible. E. R. W.

Electrification of a Large Gold Mine. J. F. WIGGERT. *Gen. Elec. Rev.*, **32,** 477–90 (Sept., 1929).—The use of electrical equipment at the Homestake Mines at Lead, S. D., has increased from 1879 to the present until the majority of the mining operations use electrical equipment. The telegraph was first, followed in a few years by a lighting system. Development was slow at first, but as electric power showed itself suitable, has become increasingly rapid. Much of the equipment has been built by the mining company to meet its own conditions of operation.

The ore together with water is fed into a stamp mill in which it is ground to a fine sand liberating fine particles of gold. Mercury is added to the mixture, and the whole run over copper plates which have been silver plated and amalgamated with mercury. The particles of mercury-wetted gold are caught on the plates and brushed off periodically. The mercury is recovered by distillation, and the gold further refined. 65% of the gold is obtained this way. The coarser sand is leached with cyanide solution. The slimes offered difficulty which was overcome by using great iron presses in which the slimes are set up in thin vertical layers and leached. The gold is recovered from the cyanide solution by precipitation with zinc.

The price of gold has remained practically constant, while labor and other costs have increased. The struggle for survival of companies producing low-grade ore has necessitated the development and use of more efficient equipment. H. T. B.

Amyl Alcohol from the Pentanes. E. E. AYRES. *Ind. Eng. Chem.*, **21,** 899–904 Oct., 1929).—At the plant of the Sharples Solvents Corp. 22 tons of chlorine are fed into a 60-mile-per-hour stream of hot pentane vapor daily. The reaction is complete in $2^1/_2$ seconds and not more than 8 oz. of free chlorine are in contact with the pentane at any given moment. The products are separated by fractionation into 33 tons of HCl of 21° Bé., a small amount of polychloride residue and pure amyl chloride. The amyl chloride is hydrolyzed with caustic soda, and the NaCl formed is electrolyzed to produce chlorine. The vapors from hydrolysis consist of (1) amyl chloride which is returned for hydrolysis, (2) amylene, which is hydrated to amyl alcohols, (3) diamyl ether, (4) amyl alcohol for special uses, (5) a mixture of amyl alcohols marked under trade name Pentasols, for use in lacquer industry. The source of pentane is natural gas gasoline which contains 20–40%. Gives an account of the chlorination process, and prod-

ucts formed under different conditions, and the conversion of the chlorides to alcohols. D. C. L.

The Manufacture of Anhydrous Ethyl Alcohol. D. B. KEYES. *Ind. Eng. Chem.*, **21,** 998–1001 (Nov., 1929).—The manufacture of absolute alcohol from 95% alcohol was first accomplished in the United States on a commercial scale, but several writers have given most credit to French inventors. This article traces the development of this process through its various stages by means of patents giving the features covered by each. D. C. L.

Solvents. R. H. FRENCH. *Chem. Markets,* **25,** 369–71 (Oct., 1929).—A brief general discussion of commercial solvents. H. H. K.

Cyanamide and Its Uses. F. E. ALLISON. *Chem. Age,* **21,** 401–2 (Nov. 2, 1929).—Calcium cyanamide, prepared from calcium carbide and atmospheric nitrogen, is used chiefly as a fertilizer. If cyanamide is mixed with superphosphate, reactions may take place which convert both ingredients to forms which are not readily available for plant growth. For best results cyanamide should be applied alone and in a fresh condition since it deteriorates on standing in contact with air and moisture. E. R. W.

Synthetic Camphor Is Made in New Jersey. *Oil, Paint Drug Reptr.,* **116,** 21 (Nov. 25, 1929).—Production of synthetic camphor by the Belle Chemical Co., Belleville, N. J., is expected to begin about January 1st. M. W. G.

A New Method for the Production of Pure Beryllium Oxide from Beryllium Ores. H. A. SLOMAN. *Chem. & Ind.,* **48,** 309T–16T (Oct. 18, 1929).—Beryllium oxide is used in the electrolytic production of metallic beryllium. Beryl, a beryllium aluminum silicate, is roasted with sodium silicofluoride to form beryllium fluoride which is then converted to the sulfate, heavy metal impurities are removed as hydroxides and sulfides. Beryllium hydroxide and beryllium sulfate are then converted to the oxide by roasting with carbon black. E. R. W.

Konel. EDIT. *Tech. Rev.,* **32,** 30 (Nov., 1929).—A timely example of what the iron alloys committee hopes to stimulate in its field is at hand in the form of an announcement of the non-ferrous alloy, Konel, produced by E. F. Lowry of the Westinghouse Company.

Konel, an alloy of cobalt, nickel, and ferrotitanium, is harder than steel, and retains its strength at high temperatures. The presence of cobalt in Konel is of special interest because the use of this metal has hitherto been limited chiefly to the ceramics industry. Under the blow of a test hammer which would crush steel the new alloy when heated red hot shows no loss, according to reports, of those qualities found in the hardest metals when cold.

Already Konel is substituted for platinum in forming the heating elements of radio tubes and many other possible uses present themselves upon a moment's reflection. For instance, one of the stumbling blocks preventing the utilization of steam at extremely high temperatures is the lack of a metal which retains its strength at high temperatures, and Konel may fill the bill. The recent interest in chromium-nickel alloys has been inspired by the need of such an alloy in the construction of reduction furnaces lined with metal instead of firebrick. S. U. H.

Titanium Dioxide: A Revolutionizing Factor in the Pigment Market. E. W. BOUGHTON. *Chem. Markets,* **25,** 380–2 (Oct., 1929).—Titanium pigments are ideal and represent a progress in white pigment production. H. H. K.

Vanadium. *Vancoram Rev.,* **1,** 7–9 (Oct., 1929).—A brief account of the discovery and uses of vanadium. H. H. K.

Iron Alloys Committee. See this title under **Contemporary News and Comments** in **Chemistry and Education,** page 699.

The Welding of Ferrous and Non-Ferrous Metals by the Atomic Hydrogen Flame. R. A. WEINMAN. *Gen. Elec. Rev.,* **32,** 532–7 (Oct., 1929).—Hydrogen atoms provide a convenient medium for the transmission of energy to the material being welded, by virtue of the fact that the energy absorbed in splitting the molecules in the arc is released in the cooler regions when the atoms recombine. No combustion takes place in the flame proper.

Tungsten and molybdenum may be welded, but must be protected by a mantle of molecular hydrogen to prevent oxidation. The temperature used in the process causes a marked grain growth, resulting in a loss of ductility, and limiting the use of welds to objects which are not exposed to excessive vibration. Metals and alloys of lower melting point may be welded successfully. Cast iron must be permitted to freeze first in the bottom of the weld to prevent shrinkage cavities. It is desirable to heat castings to semiplastic condition. Worn surfaces on tools may be built up by the welding process and machined as new metal. High carbon steels lose carbon when welded, but some

alloys lose little. Aluminum oxide is reduced at a temperature above the melting point of aluminum—a fact which necessitates the use of a reducing agent as a flux. Care must be taken to prevent excessive evaporation of constituents of alloys which melt at widely different temperatures.

The atomic hydrogen flame has been used to weld materials that have given difficulty heretofore. H. T. B.

The Development of Modern Methods of Testing Lubricating Oils. J. C. JENNINGS. *Chem. & Ind.*, **48,** 1104–9 (Nov. 15, 1929) and 1128–32 (Nov. 22, 1929).—A detailed review of the methods of testing oils used in England and in the United States. The following tests are included: viscosity, cold test or pour point, coke test, demulsibility, oiliness, oxidation, and stability. Many of these tests are purely empirical, the results obtained in different laboratories differing greatly with slight differences in procedure. The great need for standardization of tests is pointed out. E. R. W.

Rubber Cements. S. D. SUTTON. *India Rubber World*, **81,** 58 (Dec., 1929).—Review and discussion of problems and methods of manufacture, applications, and uses of cements are given along with a few good recipes. C. W. E.

Vulcanization of Rubber. I. OSTROMESTENSKY. *India Rubber World*, **81,** 55 (Dec., 1929).—The following summaries are given with discussion regarding the recent researches in the vulcanization of rubber. (1) Organic peroxides vulcanize rubber not only in absence of sulfur but likewise without any metal oxides or accelerators. (2) Rubber vulcanized by means of benzoyl peroxide give soft rubber similar in physical properties to the product from sulfur vulcanization. (3) Vulcanization with benzoyl peroxide is complete in a short time at low temperatures. (4) Possibility that vulcanization with benzoyl peroxide may lead to soft, transparent, and elastic product which is almost colorless. (5) Sulfur aids in the protection from decomposition. C. W. E.

Natural and Synthetic Rubber. I. Products of Destructive Distillation. II. Reduction of Isoprene by Na-NH_3. III. Dimethyloctadiene. T. MIDGLEY, JR., AND A. HENNE. *Rubber Chem. Tech.*, **2,** 441 (July, 1929).—*Part I.* All products isolated from destructive distillation of natural rubber are directly derived from the rubber molecule by simple reactions. *Part II.* Reduction of isoprene with Na in liquid NH_3 gives 60% of 2-methyl-2-butene. *Part III.* Isoprene, potassium, and ethyl alcohol mixed give a mixture of dimethyloctadienes. This reaction indicates that the mechanism of the polymerization of isoprene to synthetic rubber is the joining of many isoprene molecules by definite linkages of the carbon atoms to produce a long chain molecule. C. W. E.

Absorption of Oxygen by Rubber. G. T. KOHMAN. *Rubber Chem. Tech.*, **2,** 390–3 (July, 1929).—Discussion of relation between natural aging and oxygen absorption at 80°C. Apparatus described to follow absorption of O_2 at const. pressure and temp. over long periods. Absorption of O_2 is autocatalytic and appears to consist of at least two separate reactions—decomposition and addition. Rate of absorption of O_2 varies as area, degree of cured rubber, anti-agers present, allotropic forms of O_2, heat, etc., are discussed at length. C. W. E.

Recent Developments of Window Materials and Fabrics for Transmitting Ultra-Violet Radiations. W. W. COBLENTZ. *Glass Ind.*, **10,** 233–6 (Oct., 1929).—"In this paper the following topics are discussed: (1) An estimate is obtained of the amount of the short wave-length ultra-violet solar radiation that is shut out by common window glass. (2) Statistical data are given on the transmissive properties of various newly developed window glasses and glass substitutes for transmitting the short wave-length ultra-violet solar radiation; also data on the decrease in transmission that these glasses undergo on exposure to the sun and to artificial sources of ultra-violet radiation. (3) Data are given on the transmission of fabrics, and the reflection of paints for ultra-violet radiation." H. H. K.

New Tests of Ultra-Violet Ray Transmitting Glass. *Glass Ind.*, **10,** 276 (Nov., 1929).—Experimental data are given which prove that the use of a mercury lamp in determining loss of transparency of glasses (solarization) when exposed to natural sunlight gives misleading results. Artificial solarization is greater than that resulting from natural sunlight, and glass so treated regains some of its transmitting power when exposed to sunlight. H. H. K.

Hygienic Effects of Ultra-Violet Radiation in Daylight. H. P. GAGE. *Glass Ind.*, **10,** 238–42 (Oct., 1929).—"This communication follows an endeavor to find out what benefits can be expected from ultra-violet irradiation, and especially that due to the intensity and region of ultra-violet contained in sunshine."

Data on the effect of direct sunlight, and that transmitted through various window

materials in the treatment of rickets, colds, tuberculosis, and pernicious anemia are given. H. H. K.

Fused Quartz Window Panes in World's Largest Solarium. *Glass Ind.*, **10,** 237 (Oct., 1929).—A brief account of the method of making sheet quartz glass. H. H. K.

SCIENTIFIC REVIEWS AND BIBLIOGRAPHIES

Properties of Vanadium and Its Compounds. *Vancoram Rev.*, **1,** 10–35 (Oct., 1929).—Abstracts of patent and periodical literature. H. H. K.

HISTORICAL AND BIOGRAPHICAL

Ernest Rutherford. *Les Prix Nobel en* 1908. P. A. Norstedt & Söner, Stockholm, Sweden. **1909,** pp. 56–58.—A brief account of life of Rutherford up to the time of receiving the Nobel Prize in 1908. List of publications through 1908 is appended. Portrait same as one used for frontispiece in THIS JOURNAL, page 492. M. W. G.

Ernest Rutherford. E. ASCHKINASS. See **Recipients of the Nobel Prize in 1908** directly below.

Recipients of the Nobel Prize in 1908. *Chem.-Ztg.*, **32,** 1197–9 (Dec. 9, 1908).—Description of the lives and work of the 1908 prize winners in all fields. The account of Rutherford was written by E. ASCHKINASS. M. W. G.

In Honor of Mme. Curie. See this title under **Contemporary News and Comments in Chemistry and Education,** page 699.

Kasimir Fajans. See note under **Cornell University,** in **Local Activities,** page 707.

Robert Robinson Succeeds Perkin, Jr. See this title under **Contemporary News and Comments in Chemistry and Education,** page 699.

Edwin E. Slosson. H. E. HOWE. *Science,* **70,** 443–4 (Nov. 8, 1929).—Obituary notice. G. H. W.

Frank Austin Gooch. OBIT. *Harvard Alumni Bull.*, **32,** 19 (Sept. 26, 1929).—'72—Frank Austin Gooch, Ph.D. and A.M. '77, A.M. (Hon.) (Yale) '87. Died at New Haven, Conn., August 12, 1929. He was a well-known teacher of chemistry. From 1885 to 1918 he was professor of chemistry at Yale University, and retired in the latter year as professor emeritus. He had also been director of the Kent Chemical Laboratory at Yale. After his graduation from college he continued his studies in Cambridge and also in Europe. From 1879 to 1881 he was an expert for the U. S. Census Bureau. From 1881 to 1884 he was chemist of the Northern Transcontinental Survey. He had been connected also with the U. S. Geological Survey. He was a member of many learned societies and author of several books and many papers, chiefly on chemical subjects. S. W. H.

Frank Austin Gooch. C. L. JACKSON. *Harvard Alumni Bull.*, **32,** 68 (Oct. 10, 1929).—In the obituary of Frank Austin Gooch the statement, "He was a well-known teacher of chemistry" certainly is an inadequate account of a man whose name has become part of the language of every nation civilized enough to have chemists.

A "gooch" means one of the pieces of apparatus invented by him, which is both a filter and a crucible. This has increased the speed and convenience of quantitative analysis in factories as well as in the laboratory, and—even more important—it has made it possible to avoid the paper filter, the most frequent and harmful source of error in this class of work.

Even without this great invention, his contributions to quantitative analysis are enough to deserve mention, as his descriptions of these form a large volume, and they have to do with nearly every branch of the subject. S. W. H.

William Henry Perkin, Jr. ANON. *Chem. & Ind.*, **48,** 1008–12 (Oct. 18, 1929).—This obituary contains, besides an outline of the life of the late Professor Perkin, a rather brief summary of his chief lines of research. These, classified according to subjects, are treated under the following heads; the polymethylenes, camphor, the terpenes, the berberine group, brazilin and haematoxylin, harmine, and harmaline. E. R. W.

Edgar Fahs Smith. *J. Am. Chem. Soc.*, **51,** 54–80 (Nov., 1929).—A brief biographical sketch of the life of Edgar Fahs Smith and an appreciation of a life of inspiration and productiveness by a friend and comrade, F. P. Venable. This is followed by a detailed report of M. T. Bogert of his many publications and the publications resulting from his direction of the work of graduate students. His work in chemistry falls into several fields, each of which is taken up in detail, and his contributions summarized. First is his work in organic chemistry, started while a student of the famous Friedrich Wöhler at Göttingen where his dissertation for the doctorate was in organic chemistry. Next is his work in organic, analytical, and electrochemistry, resulting in improved

methods for the purification and analysis of various elements leading then to more accurate determinations of their atomic weights. Eighteen elements were included in these determinations, a total of 20% of the known elements. Then comes his work in the field of complex inorganic acids to which he made extensive contributions. His great contributions to electrochemistry and the chemistry of the rarer elements are equaled if not surpassed by his work as historian of American chemists, the field to which he devoted the later years of his rich life. No one within the past two decades has made so many or so important contributions to this field as has he. A list of his publications is followed by a list of some thirty brochures on the history of chemistry, and seven books on this subject. In addition there is a list of thirteen books, some written by him, and several which are translations of classic books on chemistry. A photograph is included. BYCK

Richard Zsigmondy, 1865-1929. *Nature*, **124,** 845–6 (Nov. 30, 1929).—Obituary notice of Professor Richard Zsigmondy, late director of the Institute for Inorganic Chemistry at Göttingen.

Dr. Zsigmondy's early work was concerned with glass and the colors produced by the presence of metals and metallic oxides. He showed, for instance, that ruby glass owed its color to the presence of very minute crystals of metallic gold and he synthesized the purple of Cassius from colloidal gold and colloidal stannic acid. His contributions to the field of colloidal chemistry are outstanding and his work was recognized by the award of the Nobel Prize in 1925.

Owing to failing health, he retired from his duties in February, 1929, and died at his home in Göttingen in October. F. B. D.

Theodore William Richards. GREGORY P. BAXTER. From the Smithsonian Report for 1928, pp. 737–47, with 1 plate. U. S. Government Printing Office, Washington, D. C., 1929.—This account of Richards' scientific career was originally published in *Science*, **68,** 333–9 (Oct. 12, 1928). [See THIS JOURNAL, **6,** 579 (Mar., 1929).] The frontispiece is an excellent portrait of Prof. Richards. M. W. G.

Charles Moureu, 1862-1929. J. BOUGAULT. *J. pharm. chim.*, **10,** 93–5 (1929); *Chem. Abstr.*, **23,** 6 (Jan. 10, 1930).—Obituary with portrait. C. E. M.

Charles Moureu. M. DELEPINE. *Bull. soc. chim.*, **45,** 475–8 (1929); *Chem. Abstr.*, **23,** 6 (Jan. 10, 1930).—Obituary notice. C. E. M.

Charles Moureu. C. MATIGNON. *Chimie et industrie*, **21,** 1129–30 (1929); *Chem. & Ind.*, **48,** 735–6 (1929); *Chem. Abstr.*, **23,** 4381 (Sept. 20, 1929).—An obituary. C. E. M.

Paul Schutzenberger. EDIT. *Chem. & Ind.*, **48,** 1169 (Dec. 6, 1929).—"Born on December 23, 1829, at Strasbourg, the son of a professor of law and former mayor of that town, Paul Schutzenberger became one of France's most distinguished chemists, a description which he fairly earned by means of a happy combination of energy and originality. Like so many others who have become distinguished in one profession, he was first trained for another, in this case a medical career, but in 1853 Persoz invited him to carry out preparative laboratory work in Paris. In the following year he returned to a teaching post at Nulhouse, where he remained, occupying a chair at the École supérieure d'enseignement des Sciences until 1865, when he returned to Paris as assistant to Balard, then professor at the Collège de France. Being transferred in 1868 to the new Laboratoire des Hautes Etudes at the Sorbonne under the co-direction of Deville, Schutzenberger continued to impart vitality to the work of his pupils, although in the dark days of 1870 his activity was naturally interrupted by military exigencies. After the death of Balard, Schutzenberger was in 1876 nominated as his successor in the chair of mineral chemistry at the Collège de France, and in 1882 became director of the Municipal École de Physique et de Chimie. He died at Mezy-sur-Seine on June 26, 1897. Schutzenberger is well known in Great Britain as the author of an important book on "Fermentations," although his researches were by no means confined to biological chemistry. At Mulhouse he was naturally interested in industrial questions, particularly coloring matters, and he also wrote books on general chemistry, coloring matters, and chemistry applied to physiology and animal pathology. The net which he cast into the sea of knowledge was so widely spread that it is impossible here to describe its contents, which, however, included the constitution of alkaloids and albuminoid substances, new platinum compounds, and hydrosulfurous—or, as we are now taught to call it, "hyposulfurous"—acid. A comprehensive survey of Schutzenberger's life and work, by C. Friedel, is given in the *Bulletin de la Société Chimique de Paris*, **1928t** 3rd series, Vol. XIX, in a section specially paginated." [*Note:* See "Paul Schutzenberger," by T. L. Davis, THIS JOURNAL, **6,** 1403–14 (Sept., 1929).] E. R. W.

Svante Arrhenius. SIR JAMES WALKER. From the Smithsonian Report for 1928,

pp. 715–35, with 1 plate. U. S. Government Printing Office, Washington, D. C., 1929.—Arrhenius memorial lecture, delivered on May 10, 1928. Reprinted from the *Journal of the Chemical Society*, **1928,** London. Excellent portrait of Arrhenius for frontispiece. M. W. G.

Sir Humphry Davy, 1778-1829. E. A. LUM. *Pharm. J.*, **122,** 522 (1929); *Chem. Abstr.*, **23,** 5069 (Nov. 10, 1929).—Descriptive of Davy's discoveries and personality. C. E. M.

The Life of Sir Humphry Davy. J. MCCRAE. *J. Chem. Met. Mining Soc. S. Africa*, **29,** 244–53 (1929); *Chem. Abstr.*, **23,** 4381 (Sept. 20, 1929). C. E. M.

Paracelsus. G. B. LAKE. *Hexagon*, **20,** 83–5 (Nov., 1929).—"In the earliest centuries of the Christian era, the science and art of medicine rose to considerable heights. It was in this period that the great Galen lived and taught.

"But the twilight of the Dark Ages of history closed down during the sixth century and for a thousand years little or no progress was made in medicine. The monks, particularly in Constantinople, did us the inestimable service of copying the manuscripts of the Greek and Roman masters, and announced that the care of the sick was a holy duty; Galen was worshipped as a god, and who so dared to question his pronouncements and authority was anathema; the Bible and the works of Aristotle were regarded as the only recognized sources of scientific information.

"With the sixteenth century came the dawn of the renaissance of learning, and with it the beginning of modern medicine. Among the goodly company of those who made the war upon superstition and unsupported authority during this tremendous period of transition, was Theophrastus von Hohenheim, who later added several other high-sounding names to his appellation, among them Paracelsus, by which he is most generally known today.

"Paracelsus was born at Einsiedeln, in Switzerland, in 1493, and proved to be one of the most enigmatic characters in medical history as well as the clinical standard-bearer of his time. When he was sixteen years old he entered the University of Basel, and finally secured his medical degree at Ferrara, Italy, in 1515, at the age of twenty-two years.

"At this time a large group of students, doctors, unattached scientists, and pseudo-scientific charlatans was roaming all over Europe, practicing various arts, picking up a great deal of miscellaneous knowledge and experience, and sowing the seeds of rebellion against constituted authorities in the world of thought. Paracelsus joined this motley throng for about ten years and became well known as a powerful and original thinker, a man of boisterous habits and untrammeled speech; but possessing withal, a keen and critical medical instinct.

"In 1525 he tried to become respectable, and accepted an appointment as professor of medicine at Freiburg. Later he was a professor at Strassburg for a short time, and finally was made professor of medicine and town physician at Basel in 1527.

"But Paracelsus had learned bad habits during his years of wandering. He was combative and disrespectful of all authority, coarse and vulgar in his behavior, and a bully by nature and training. He gave his lectures in the low German of the common people and did not hesitate to attack Galen and Avicenna, the popes of medieval medicine. Moreover, his mind had become more or less filled with ideas of astrology, alchemy, witchcraft, and other doctrines of that sort which were rife at the time, so that he found no place in the scholastic atmosphere of the universities. He was forced out of his regular teaching positions in 1528 after having a violent dispute with the magistrates, and started out again upon the career of a peripatetic physician, teacher, drunkard, and tavern brawler.

"In all his teaching and writing he made war against intrenched dogma insisting upon the importance of personal observations of conditions and the rational interpretation of the symptoms of disease and its treatment. He was the first to put forward the idea that the processes of physical life are chemical in their nature, and that, therefore, we must look to chemistry for our remedies for the cure of disease.

"After a number of years of this strenuous and exciting life, he tried once more to settle down, in Salzburg, but this quiet period was short, for he died there in 1541, railing against traditional knowledge and false dogmas to the last.

"In forming an estimate of the place which Paracelsus should occupy in the history of medicine, there is a tendency to lay too much stress upon his personal foibles and what we now recognize as his mistaken ideas about alchemy, thaumaturgy and the like. We must not forget that he wrote "*Chirurgia Magna*," a practical treatise in surgery; introduced mercury for the treatment of syphilis; rescued therapeutics from the realm of magic; was the first to recognize the relation between goiter and cretinism; preached

asepsis, as then known; and popularized the use of laudanum, lead, sulfur, iron, arsenic, copper, tinctures, and alcoholic extracts. His complete works, published in 1589, filled ten volumes. In the light of present knowledge we must place Paracelsus among the great minds who made possible the beginnings of the science of medicine as we now know it." C. E. M.

Justus von Liebig's Geburtshaus. PUBLISHED BY H. HOHMANN, G. M. B. H., DARMSTADT, GERMANY.—A pamphlet of 20 pages containing a brief account of Liebig's life and contributions to science, and a description of his birthplace. Nine excellent illustrations and a frontispiece of Liebig are included. M. W. G.

Briefe von Justus Liebig. EDITED BY PROF. ERNST BERL, *under the direction of the Society of the Liebig-Museum in Giessen and the Liebighaus Foundation in Darmstadt, 1928.*—This pamphlet of 88 pages contains letters of Liebig recently discovered. Inquiries concerning it should be addressed to the GESELLSCHAFT LIEBIG-MUSEUM, z.H. DES HERRN. DR. FRITZ MERCK, DARMSTADT, HERMANNSSTRASSE 41, GERMANY. M. W. G.

Liebig-Wöhler Feier in Darmstadt am 7, Juli, 1928. Reprinted from *Z. angew. Chem.*, **41**, 924 (1928).—PUBLISHED BY MAURER & DIMMICK, BERLIN SO 16, GERMANY. This pamphlet consists of 63 pages and contains an account of the Liebig-Wöhler celebration held in Darmstadt July 7, 1928. A description of a visit to the Liebig-Museum in Giessen, a eulogy on Justus von Liebig by F. Haber, the Hundred Years celebration of Wöhler's synthesis of urea by A. Wohl, biographical notes on Liebig, and an account of the various items on the program of this celebration make up its contents. M. W. G.

Ortho, Meta, Para. I. History of the Introduction of the Prefixes into Chemical Nomenclature. L. DOBBIN. *Chemist Druggist*, **109**, 643 (1928); *Chem. Abstr.*, **23**, 4854 (Oct. 20, 1929).—The term "ortho" (phosphates) was first used in 1859 by Odling, following Breithaupt's naming of "Orthoclase" in mineralogy. "Para" (tartaric acid) was introduced "with more ceremony" by Berzelius in 1830, "meta" (phosphoric acid) by Graham in 1833. **II. Benzene and Some of Its Derivatives.** *Ibid.*, 643–4.—This history of its discovery and synthesis is given; also of the discovery of BzOH, $PhNH_2$, $PhNO_2$, PhOH, and PhMe. Loschmidt (1861) contrasted a "condensed" C_6H_6 group with the more open chain C_6H_{14} and constructed graphic formulas for 121 aryl compounds. **III. Kekulé; the Constitution of Aromatic Substances.** *Ibid.*, **110**, 38 (1929).—History of the benzene ring of (1866) introduced *o*, *m*, and *p* into the special nomenclature of the benzene isomerides, but actual place relations were often uncertain, causing confusion, *e. g.*, with $C_6H_4(OH)_2$. **IV. Position Isomerism; Early Views and Difficulties.** *Ibid.*, 164.—Korner (1866) introduced *o*, *m*, and *p* into the special nomenclature of the benzene isomerides but actual place relations were often uncertain, causing confusion, *e. g.*, with $C_6H_4(OH)_2$. **V. Position Isomerism; the Problems Solved.** *Ibid.*, 225–6.—The successive steps in proving the location of *o*, *m*, and *p* positions are outlined, and the methods of Körner (1867) and Griess (1874) for determining these positions are explained in detail. C. E. M.

Distillation Methods, Ancient, and Modern. G. EGLOFF AND C. D. LOWRY, JR. *Ind. Eng. Chem.*, **21**, 920–3 (Oct., 1929).—Many of the fundamental principles of distillation were practiced by the alchemists. Such principles are (1) taking several streams from one tower, (2) refluxing, (3) external regulation of still head temperature, (4) reboiling of condensates for increased fractionation, (5) preheating liquid, (6) feeding liquid into still while in operation. The article contains numerous pictures of the stills employed together with a modern unit. D. C. L.

EDUCATIONAL MEASUREMENTS AND DATA

Ability Grouping in Theory and Practice. E. A. LINCOLN. *Sch. & Soc.*, **30**, 447–53 (Oct. 5, 1929).—The results of investigations and studies of ability grouping as practiced in various schools and institutions are given in this discussion. As a summary of the different plans, several general principles are given which, in the mind of the author, will aid in devising a plan which should meet with success. K. S. H.

The Ability Group. R. P. FARRELL. *High-Sch. Teacher*, **5**, 352–4 (Dec., 1929).—Ability grouping, according to the author, is nothing much more than a long range series of assignments which recognize different levels of ability in the class to which it is made. These levels of assignment include: a minimum essential program; deferred or starred assignments, which are also recorded in the assignment book of all pupils; and finally what is called a double starred assignment for only the very fastest and most capable in the class. The third level of assignments is made "absolutely individual", and is followed up by the teacher and is "designed to lead the brilliant pupils into unsuspected fields of accomplishment and enjoyment."

The success of the plan is dependent in a large measure upon the ready manner in which a student may by the excellence of his work (or the reverse) be shifted from one level to the other. "The opportunity must be there" for each pupil. B. C. H.

Criteria for Judging Content of a General Science Course. D. B. BROOKS. *High-Sch. Teacher*, **5**, 362–5 (Dec., 1929).—Among the criteria submitted in the article are: objectives both general for education and special for science; criteria for the elimination of topics; children's interests; social and natural environment and teachers' interests.

From a comparison of a survey made by the author and one made by C. A. Pollock the conclusion is drawn that pupil interest alone is a doubtful index of worth of material for a course of study. "Other criteria besides the interests of the child must be used to evaluate (such choice of topics)." B. C. H.

THE PHILOSOPHY OF EDUCATION

What Do Our Colleges Need Most? J. M. MCBRYDE. *Sch. & Soc.*, **30**, 267–9 (Aug. 24, 1929).—Not only are our colleges in need of endowments which will make possible better laboratory and library facilities, but more especially are they in need of professors who can really teach. Ideal teachers are not easily found and are fast becoming extinct—a situation even more apparent since the stress laid upon the Ph.D. degree as a requisite for a professorship. That this degree represents certain achievements is true, but scholarship guarantees little or nothing concerning the teaching ability of an individual. One who can humanize knowledge, thus inspiring his students with a love for the subject, and who through high moral character leaves an indelible impression on all those with whom he comes in contact is, in the mind of the writer, an ideal teacher. K. S. H.

Three Enemies of Education—Notebooks, Credits, and Examinations. M. F. MODDER. *Peabody J. of Educ.*, **7**, 18–20 (July, 1929); *Teachers J. & Abstr.*, **4**, 485 (Nov., 1929).—"This brief article is a comment in regard to President Glenn Frank's recent statement that the three enemies of education are notebooks, credits, and examinations. The author admits the truth of this statement, discusses it, and claims that originally notebooks, credits, and examinations were valuable means toward the end of learning. He contends that, once useful as mechanism, they have become ends in themselves and are hence the enemies of education. These enemies, he thinks, should not be destroyed but should be reconverted into helpful agencies for the purpose they were originally intended to serve. A football team, the author thinks, suggests the right attitude toward desirable studious habits. The regular sessions of the team must be attended regularly. There must be daily practice. In the necessary activities of the game and the examination is the test arising when the team meets its opponent." B. C. H.

High-School Diploma Often Meaningless. B. BEATLEY. *School*, **41**, 237 (Dec. 5, 1929).—There are two incompatible philosophies in our modern educational practice with high schools. The newer of the two demands a secondary education for all boys and girls; the second and older practices the use of "failure" as an eliminating force to guarantee that education shall be only for the best students.

It is suggested that if the more democratic plan is followed provision must be made for each type of student to have the kind of education best suited to his needs. In addition, high standards will have to be maintained by the segregation of the superior students, in order that their margin of ability over the other students may be profitably used. To carry such a scheme to its consummation would require that every student be eligible for graduation. Since "graduation is practically meaningless now" why not very candidly admit that it is a meaningless bit of pageantry and so permit every one to graduate who has served the required number of years? B. C. H.

A Forecast of Secondary School Curriculum Revision. D. SNEDDEN. *School*, **41**, 196 (Nov. 21, 1929).—"All the children of all the people will presently be coming to school up to sixteen years, and soon later to eighteen years." Entrance to vocational courses will in the new order be made after the sixteen-year limit has been reached and the period preceding that time will be spent in getting a general education.

The author thinks that the future will see the courses split into offerings determined by their functional intent. In that future day one out of ten students will take algebra for prevocational reasons and at least five out of the ten will be carefully advised not to take it; Latin will be for spiritual culture worth instead of a word-derivative value; science will be prevocational for the few and spiritually cultural for the many; even the shopwork will, in the junior (and if offered in the senior) high school, be for spiritually cultural purposes rather than for vocational guidance. B. C. H.

THE PHILOSOPHY OF SCIENCE

The Impact of Science upon Religion. *Harvard Alumni Bull.*, **32**, 90–7 (Oct. 17, 1929).—The concluding three paragraphs of this article give a good impression of the tenor of the article.

"Powers that are now inoperative in the universe, forces in nature that are not now effective, must be made operative and effective. That can be done only when human beings strive to express something more than themselves, strive to express what they believe to be the real nature of the administration of our universe.

"Toward that end science and religion must coöperate. Searching, as they are, for truth and righteousness, they must work hand in hand. The responsibility is exactly equal to the opportunity. If evolution guarantees to you and me the opportunity, then there is also placed upon us the responsibilities of responding. Dependent though we be upon human intellects and human feelings, we have abundant reason for high hope. Out of the astrology of the past came the astrology of today, a sound and valid science. Out of the alchemy of the Middle Ages emerged the chemistry of this modern time. Out of the superstition of primitive times and places is emerging a religion based upon scientific descriptions and using scientific methods of evaluating all the realities of existence.

"You do not judge chemistry by its source, the alchemy of the past. No more should you judge religion by its source. It is the fruits rather than the roots that serve as the true basis for evaluation. We are living in a world of experiments, in which we can dimly see these forces crowding for expression, attempting everywhere to manifest the real nature. We shall succeed in making the most of our opportunities only as men of science and men of religion coöperate in their search for truth and righteousness."

S. W. H.

Research and Labor: A Chemist Looks at Modern Life. A. D. LITTLE. *Tech. Rev.*, **32**, 77–8, 106, 108, 110, 112, and 114 (Dec., 1929).—We are living in an age of science, the machine, and mass production. Like all the ages which have gone before, it is not without its contemporary critics. They would have us believe that science threatens to cause the destruction of our civilization; that the worker has become the slave of the machine; and that mass production has engulfed us in materialism, converted the craftsman into the tightener of a single bolt, and robbed the world of beauty.

All this, *if true*, would be a sorry outcome of the long series of intellectual triumphs which, during the last one hundred and fifty years, have given man so large a measure of mastery over his environment.

The remainder of this article goes on to show that this indictment is unjustified, but that through research we come to automatic machinery and better manufacturing methods. These result in lower costs, lower costs permit higher wages and lower prices, both of which stimulate consumption. To meet the new demand the scale of production rises, permitting new economies, which further lower costs. To maintain mass production there must be mass buying, and mass buying is possible only with high wages.

A circular issued in April, 1926, by the General Electric Company discloses that, along with the introduction of much automatic machinery and improved methods, it increased the number of workers from 15,600 (1914) to 21,000 (1925); their average income was increased during this period 107 per cent, while the cost of living went up only 68 per cent. Similarly, the money value of the annual product increased 179 per cent; and, although the average of commodity prices had increased 62 per cent, the average price of all General Electric products had risen only 16 per cent while in some cases, for instance, incandescent lamps, was lower than in 1914.

But even in a machine age there is still hope for the creative arts. The machine is saving us much time. We produce, transport, and distribute the necessities of life with the expenditure of a small fraction of the time and effort required of our forefathers.

The time cost of living has gone down. The machine is creating leisure, and we now need schools to instruct us in its use.

S. W. H.

The Popularization of Science. W. A. HAMOR AND L. W. BASS. *Science*, **70**, 632–4 (Dec. 27, 1929).—See Digest in this issue of the JOURNAL, pages 678. G. H. W.

Industrial Progress Made through Research and Its Economic Importance. W. R. WHITNEY. *Gen. Elec. Rev.*, **32**, 586–9 (Nov., 1929).—Early man was forced to labor for the necessities of life; need was ever upon him. It was but natural that a dislike for extra work arose. Fortunately there arose also the counterpart—natural curiosity. Man began to assume some of the attributes of the Creator; things he did not like he changed.

"Research is a parent of industrial growth, the other parent being the will to live better." Under an industrial system in which research plays a large part, it is logical that manufactured articles should be superseded by others. Manufacturing concerns

must be able to adjust themselves to changing conditions. Research has made for orderliness and has for its aim "the discovery of untested materials and processes, better use of old materials, to reveal new wants, create new desires, and actually predetermine new needs." "There is some danger of over-popularizing industrial research. The result of attracting special attention to research may be to suggest something essentially false, such as a general panacea for work or a cure for all economic ills.

"Science is teaching us that impartial and truthful experiment is more serviceable than any amount of emotional persistency or unemotional fixity." H. T. B.

PROFESSIONAL

Qualities of Merit in Good and Poor Teachers. A. R. MEAD. *J. Educ. Research*, **20**, 239–59 (Nov., 1929).—See Digest in this issue of the JOURNAL, pages 675–7. R. M. P.

Academic and Professional Training of Science Teachers in Wisconsin. G. ZEISMER. *Sch. Sci. Math.*, **29**, 931–42 (Dec., 1929).—During the school year 1926–27 a questionnaire was sent out on "Teaching of Science in Senior High Schools of Wisconsin" to discover among other things: (1) to what extent has the science teacher made academic and professional preparation for his work; (2) how many years ago have the science teachers graduated from training institutions, and when did they last pursue professional courses.

Approximately 37% response was obtained and data received and tabulated indicates that if the standard set by authorities in education on the minimum training necessary for high-school teachers—namely, graduation from a standard college or university with twenty to thirty semester hours' credit in professional work—is accepted, many science teachers in Wisconsin are sadly lacking in both academic and professional training. Approximately 40 per cent of the teachers have had less than 35 months of study at teacher training institutions, while slightly more than 50 per cent have met the academic requirement and hold degrees from standard institutions. Seventy-seven per cent of these teachers graduated within the last nine years (since 1917) and 56 per cent graduated within the last three years (since 1923). Approximately 60 per cent of the teachers pursued professional courses within the past six years. About 70 per cent of the teachers meet the professional requirement of 15 semester hours credit, while 45 per cent have 20 or more semester hours credit. Science teachers, in general, do not pursue professional courses to any great extent beyond the standard requirements. The median number of semester hours credit in science is 40.75. Forty per cent of the teachers have not majored in science and, obviously, are not prepared, or very meagerly prepared at best, to teach the science subjects. B. H. B.

Investigating the Value of Professional Courses in Education. M. HOOR. *Bull. Am. Assoc. Univ. Profs.*, **15**, 558–62 (Nov., 1929).—A committee of the Tulane chapter of the American Association of University Professors in this article attempts to bring together some current opinions and criticisms of the "increasing development of professional courses in 'education' and the constantly expanding legal prescription of such courses for prospective teachers in primary and secondary schools." It further seeks to get the National Officers to submit Tulane's request for a committee to study this matter to the National Council at its next meeting. The committee from the Tulane chapter presents a series of problems which it considers pertinent to the matter under investigation. In this list of questions some representative ones are: "(1) Is time spent on professional 'education' subjects too large a fraction of the time spent by students in preparation for teaching? (2) Is the assumption sound that training in methods must precede or accompany training in content to be taught? (3) Should methods courses not be given, or at least directed, by men who have specialized in the content subject of the methods course? (4) Is the present tendency to separate content, offered by Arts and Science Colleges, and methods courses, offered by Teachers' Colleges, sound educational policy? (5) Have such professional and educational courses actually prepared more efficient teachers than were to be had in the days before such requirements were made? (6) Should institutions of higher education not require such professional training of the members of all faculties if such training is all that is claimed for it by its advocates?" B. C. H.

Is There an Age Dead-Line in the Scientific and Engineering Professions? W. A. HAMOR AND L. W. BASS. *Science*, **70**, 426 (Nov. 1, 1929).—An analysis of the applicant file at the Mellon Institute leads the authors: To conclude, our experience would indicate that at the present time an older man, qualified with respect to technical ability and personal attributes, is not handicapped by his age, in spite of the progress made in

technical education in recent years, in addition to the other considerations which have been cited as causative of an age dead-line." G. H. W.

Educating the Educators. Part I. The Contribution of the Graduate Schools. R. L. KELLY. *Assoc. Am. Coll. Bull.*, **15,** 342–79 (Nov., 1929).—In this article are presented the specific recommendations of the Association of American Colleges submitted by the Association's Commission on the Enlistment and Training of College Teachers at the fifteenth annual meeting of the Association, January, 1929, for the training of graduate students for college teaching. Believing that the two major elements in the graduate training of prospective college teachers should be mastery of content of the subject matter to be taught and some experience in research within the field of the subject, the Association offered the following suggestions toward the perfecting of the training of prospective college teachers in the institutions which are members of the Association of American Universities: (1) that each graduate school regularly ascertain from its doctoral candidates whether or not they intend to be college teachers; (2) that no school admit to candidacy for the doctorate any student intending to engage in college teaching who has not a broad range of intellectual interest and experience; (3) that each prospective candidate be given training in methods of teaching as applied to his field; (4) that each graduate school offer a course on the American College; (5) that the research requirement be reduced in favor of additional mastery of subject matter; (6) that departmental heads learn the teaching ability of their graduate students.

The replies of twenty-six American universities and two Canadian are appended. They are all in sympathy with the desire to raise the teaching effectiveness of students receiving higher degrees, but they are not agreed on the means by which this may be done. Some doubt the desirability of a course on the American College; others do not feel it advisable to establish separate courses in methods of teaching since in some instances more than half of the candidates for the Ph.D. degree are assistants or instructors. Five universities were decidedly not in favor of modifying the research requirement. Johns Hopkins University replied that preliminary plans have been carefully formulated for the preparation of college and university teachers in chemistry, a Chair of Chemical Education provided by Mr. Francis P. Garvan of New York City, having been established in the chemistry department. Clark University reported that for several years they have had provisions for the very training recommended in their School of Geography. G. O.

Who Shall Supervise College Teaching? O. A. ANDERSON. *Sch. & Soc.*, **30,** 645–7 (Nov. 9, 1929).—If supervision of teaching is to be introduced into institutions of higher learning, certain obstacles are bound to evolve which must of necessity find some solution. The fact that college teaching has never been supervised, coupled with the idea that such supervision would no doubt interfere with one's sense of academic freedom, makes the situation a more or less difficult one to meet. And with an insufficient supply of persons competent to supervise, the problem becomes even more complicated.

The writer suggests that supervision of this nature be introduced as a service function—the personnel to be as carefully selected as are college presidents. K. S. H.

Fifty-Five New College Presidents. A. M. PALMER. *Assoc. Am. Coll. Bull.*, **15,** 380–91 (Nov., 1929).—When forty-five changes among college and university presidents occur and at least ten vacancies are reported, Archie M. Palmer thinks it is time for those interested in the welfare of the American college to take notice. This article reveals some pertinent facts about the presidents of American colleges for the year 1929. A greatly condensed statement of the author's findings is given here.

By states Illinois and Ohio have had the largest number of changes.

Previous Experience: It is very significant and reassuring to note the large number of new presidents who have been specifically trained for the tasks they are assuming. Many have been both college teachers and college administrators. As college teachers the largest number have been in the field of (1) education, (2) theology or religious education, (3) social sciences.

Vital Statistics: Age—30–66; av. age—48; place of birth—24 states and 4 foreign countries; degrees: B.A. (all but one); M.A.—14; Ph.D.—15; LL.B.—4; B.D.—10; studied abroad—5; Phi Beta Kappa—18.

Motives: A full recognition of the function and value of the undergraduate college of liberal arts and sciences and a conviction that it is "the critical link in our educational chain." G. O.

CONTEMPORARY NEWS AND COMMENTS IN CHEMISTRY AND EDUCATION

Organic Symposium at Princeton. *Ind. Eng. Chem., News Ed.*, **8,** 8 (Jan. 10, 1930).—Report and photographs. M. W. G.

Kasimir Fajans, Holder of the George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University, 1930. See note under **Cornell University** in **Local Activities,** page 707.

Dedication of the George Herbert Jones Laboratory at the University of Chicago. *Ind. Eng. Chem., News Ed.*, **8,** 3–4 (Jan. 10, 1930). M. W. G.

Memorial Service for Edgar Fahs Smith. The Provost of the University of Pennsylvania Presiding. W. B. IRVINE. *Auditorium, University of Pennsylvania, December 4, 1928. Brochure, 62 pp. Chem. Abstr.*, **23,** 4381 (Sept. 20, 1929).—Contains a portrait of Smith, a biographical summary, a bibliography of his publications and of Ph.D. theses prepared under his direction, the invocation and benediction by Richard Montgomery, and memorial addresses by Francis Xavier Dercum, Marston Taylor Bogert, and Josiah Harman Penniman. C. E. M.

Dr. Arthur Harden: Nobel Prizeman. ANON. *Chem. Age*, **21,** 441 (Nov. 16, 1929).—The Nobel Chemistry Prize for 1929 was awarded jointly to Dr. Arthur Harden, head of the department of biochemistry at the Lister Institute of Preventive Medicine; and to Professor Hans Euler, of Stockholm. These men have been active in the study of enzymes and fermentation. E. R. W.

Sir Frederick Gowland Hopkins: Nobel Prizeman. ANON. *Chem. Age*, **21,** 419–20 (Nov. 9, 1929).—The Nobel Prize for Medicine and Physiology for 1929 has been divided between Professor Sir Frederick Gowland Hopkins, of Cambridge University, and Professor Christian Eijkman of Utrecht University. This article contains a brief review of Professor Hopkin's work with vitamins and with glutathione. E. R. W.

The Davy Medal—Gilbert N. Lewis. *Harvard Alumni Bull.*, **32,** 306 (Nov. 28, 1929).—Gilbert N. Lewis, A.B. '96, A.M. '98, Ph.D. '99, Harvard, who has been since 1912 professor of physical chemistry and dean of the college of chemistry at the University of California, has received the Davy Medal from the Royal Society, the oldest scientific body in Great Britain. The medal, which is given annually for the most important chemical discovery in Europe or Anglo-America, was awarded to Dean Lewis for his contributions to classical thermodynamics. He was an instructor in chemistry at Harvard in 1899–1900 and from 1901–1906, but was on leave in 1904–1905, when he was in charge of weights and measures in the Philippine Islands. In 1907 he was appointed assistant professor of chemistry at the Massachusetts Institute of Technology and was promoted to associate professor there in 1908 and to full professor in 1911. He received the honorary degree of D.Sc. from the University of Liverpool in 1923. In 1925 he was Silliman Lecturer at Yale University. He is a member of several scientific societies and organizations and the author of three books—"Thermodynamics and the Free Energy of Chemical Substances" (with another), **1923;** "Valence and the Structure of Atoms and Molecules," **1923;** and "The Anatomy of Science," **1926.** S. W. H.

In Honor of Mme. Curie. *Science*, **70,** 446–7 (Nov. 8, 1929).—A brief summary of the significant occasions during Mme. Curie's recent visit to the United States. G. H. W.

Robert Robinson Succeeds Perkin, Jr. *Nature*, **124,** 994 (Dec. 28, 1929).—Professor Robert Robinson is the new Waynefiete Professor of Chemistry at the University of Oxford. He has been described as the most brilliant pupil of his illustrious predecessor, the late W. H. Perkin, with whom he has been associated in the solution of many of the outstanding problems in the chemistry of the alkaloids. His work also has dealt with the structure and synthesis of plant products and the mechanics of plant metabolism. His constructive and original work was recognized by the Langstaff medal in 1927.

It is fortunate that the chair at Oxford has been filled by another master in synthetic chemistry who can carry on the Perkin tradition. F. B. D.

Commission on the Reform of the Nomenclature of Organic Chemistry. A. F. HOLLEMAN. *Rec. trav. chim.*, **48,** 641–51 (1929); *Chem. Abstr.*, **23,** 5465 (Nov. 20, 1929).—Report of the chairman of the Comité de Travail, with amendments by the Commission (made at the Hague meeting of the I. U. P. A. C.), comprising 69 rules. (It is expected that the report will be further considered at the Liège meeting in 1930.) C. E. M.

Iron Alloys Committee. *Tech. Rev.*, **32,** 29 (Nov., 1929).—European countries have been more fecund in the production of new alloy metals than the United States, a fact that does not require a World Engineering Congress for its demonstration. Our research has been sporadic, unorganized, and duplicative. The newly formed iron alloys committee of nine, headed by George B. Waterhouse, professor of metallurgy at M. I. T.

is to inquire into all "basic data on iron and its very numerous combinations with other metals and certain metalloids."

The work of the committee, which is to keep America in the front lines of the special steel industry, is to consist of two parts: the first is collecting, putting into usable form, and appraising all the written material on these subjects so that it may be available for the convenient use of research workers, technologists, and engineers. The results of research now in progress in the iron, steel, and related industries will be published by the committee in the form of monographs for research workers and manuals for men in the shops and foundries. The second part will be to aid, promote, and organize research to obtain new basic information about pure iron and its combinations with other substances. It will be the work of the coöperating laboratories rather than of the committee to discover new chemical alloys. Five years and at least $150,000 will be spent to initiate what is hoped will be a permanent procedure. S. W. H.

The Advisory Committee on National Illiteracy. E. EVENT. *Sch. & Soc.*, **30,** 708 (Nov. 23, 1929).—The personnel of a committee appointed by Secretary Wilbur for the purpose of attempting to meet the apparent widespread problem of illiteracy is given. Through some of the new agencies, such as the radio, and also by means of correspondence courses, the committee hopes to reach isolated communities where educational opportunities are not available. K. S. H.

FOREIGN CHEMICAL AND EDUCATIONAL CONDITIONS

One Hundred Years of Chemistry in the Stüttgart Technical College. E. SAUER. *Chem. App.*, **16,** 93–6 (1929); *Chem. Abstr.*, **23,** 4854 (Oct. 20, 1929).—A discussion of the development of the college. C. E. M.

GENERAL

The Publication of Papers from Research Institutions. C. E. K. MEES. *Science*, **70,** 502 (Nov. 8, 1929).—The publication of research papers in privately issued journals restricts the dissemination of such information as they contain. This situation is made worse by the insistence of some of these journals on rights of prior publication, sometimes actually making papers read before scientific societies unavailable for the journals of these societies. G. H. W.

The Binding Influence of a Library on a Subdividing Profession. H. CUSHING. *Science*, **70,** 485 (Nov. 22, 1929).—Address at the dedication of the William H. Welch Medical Library, Baltimore, October 17, 1929. The theme of this address is summed up in the concluding paragraph: "a library made useful not as a passive but an active force; one that is 'not vocational but cultural, not final but initiative;' one that will serve as a common meeting-ground where the different streams of knowledge may coalesce; one where an interest in the history of our great profession will so flourish as to permeate into all departments of a much-divided school; a place from which the appeal of scholarship free from pedantism will radiate to long generations of future students—a place, in short, where Medicine, the foster-mother of the sciences, once more in close contact with her whole family will imbue them all with the spirit of that ancient phrase, 'Where there is love of humanity, there will be love of the profession.' " G. H. W.

The Reaction of American Public Opinion to Chemical Warfare. C. I. CROCKETT. *Chem. Warfare*, **15,** 649–68 (Nov. 15, 1929).—In the World War, "the total casualties of the British army from weapons other than gas were 1,908,810, of whom 700,137 or 36.6% died." "The total casualties from gas were 180,981 of whom 6062 or 3.3% died." "The total casualties for the United States army from weapons other than gas were 187,586, of whom 46,519 or 24% died. The total casualties from gas were 70,752, of whom 1421 or 2% died." "The total casualties of the German army from weapons other than gas were 4,186,116, of whom 1,806,275, or 43% died." "The total casualties from gas were 78,663, of whom 2280, or 2.9% died." Figures such as these are responsible for the slow but sure change of American public opinion from opposition to support of chemical warfare as an efficient, and as nearly humane as possible, means of fighting. E. R. W.

The World-Wide Influence of Industrial Research. E. R. WEIDLEIN. *Chem. Markets*, **25,** 372–4 (Oct., 1929). H. H. K.

Sanitary Control of Swimming Pools. M. E. SMITH. *Rept. New Eng. Assoc. Chem. Teachers*, **31,** 43–50 (Nov., 1929).—The problem of the sanitary control of a swimming pool involves the consideration of three essential elements: (1) design, (2) supervision, (3) maintenance.

Locating the pool in the basement of a building has many undesirable features from

the standpoint of ventilation and lighting. Special attention should be given to scum-gutters and runways.

The water is first made alkaline with sodium carbonate; then the finely divided material is coagulated with alum. After this the water is filtered but still contains bacteria. A dose of chlorine as low as 0.2 part per million of water is sufficient to destroy all the bacteria.

There is no excuse for an unsanitary condition of a pool which has proper equipment and an intelligent operator. O. C.

Salt Played Large Part in Shaping Mexican History. Man's craving for salt, a physiological yearning only recently understood but followed blindly throughout history, has been an important factor in the distribution of races.

The influence of salt in the early history of America, particularly Mexico, the cradle of native American civilization, is traced by Miguel O. de Mendizábal, ethnologist, in a monograph issued by the Mexican National Museum.

While the modern world has solved and forgotten its salt problem, it was still a burning question in the civilized world a few centuries ago, and there are many regions today where it retains its old importance. In parts of the Mexican state of Guerrero, to cite an example, salt is used as money in exchange for other commodities, just as it was in the great Aztec markets that Cortes saw.

It is only the primitive hunting and fishing tribes living on almost purely animal diet that are independent of salt, as the animal tissues they eat automatically supply it. But with races whose diet is mixed or vegetarian, the search for salt has been as important as the search for water. Tribes, states, and empires that possessed permanent sources of salt were great political powers, and those that did not have it had to sell their birthright for it.

In ancient Mexico wars were fought over salt, salt was an important regular tribute paid by vassals to their lords, and salt was incorporated in religions and myths. Vixtocioatl, the Mexican Salt Goddess, was a sister of the important rain gods. In Tecuilhuitontli, the seventh month of the Mexican year, which the historian Clavijero says started on June 26th, the fiestas to the Salt Goddess began, and all the salt makers, young or old, danced, and the salt merchants offered slaves in sacrifice. Salt was the first thing to give up in religious fasts, and the first thing prohibited to the common people in war times as a conservative measure.

As salt was essential in the extraction of silver by the mercury-amalgam process in the Mexican mines, before the use of cyanide was discovered, Spain found it necessary to control all local sources of salt, and Mexican colonial archives contain a great deal of varied information which Mr. Mendizábal has used in his study. Every salt point of any importance was known, and the mapping of these in connection with the distribution of races graphically indicates the importance of salt in the political relationships of the Mexican Indian nations.—*Science Service*

New Petrified Forest Discovered in Montana. A new petrified forest, the only one so far discovered with the trees lying as they fell millions of years ago, is reported by the U. S. Bureau of Reclamation. It was found by a road-building expedition on the Lower Yellowstone reclamation project, about three miles southwest of Savage, Montana.

The petrified forest covers several acres. Some of the trees are ten feet in diameter and over 100 feet long. They all lie with their tops pointing in the same direction, indicating that they may have been blown down by a storm. The shape of the trunks suggests that they belonged to the same forests that supplied the materials for the nearby beds of coal.—*Science Service*

Local Activities

Purpose and Organization

The purpose of the Local Activities Section of the JOURNAL OF CHEMICAL EDUCATION is briefly but clearly stated in its title. Any items of local news from institutions, A. C. S. Sections, Teachers' Associations, or other organizations which are of such a nature as to make them of more than purely local interest rightfully belong to this Section.

The responsibility of reporting items for this section rests entirely with the local institutions and organizations. It is desirable to have a representative appointed to report news regularly. Suitable material sent to the editorial office before the 20th of each month will be published in the following month's journal. The Editorial Staff must necessarily reserve the right to abridge or totally reject any items submitted. If the following suggestions are followed, however, the necessity for such action will be largely obviated.

Material to Be Reported

1. Notices of local scholarships or fellowships and announcements of new or unusual courses in chemical education or special fields of chemistry.
2. Reports of dedication of new science buildings, stressing the unique features.
3. News notes concerning activities of prominent scientists and educators and of the honors and awards made to them.
4. Promotions within, or changes of, personnel of a department.
5. Notices of any special gifts to chemical organizations or departments—as fellowships, endowments, laboratory gifts, library gifts, etc.
6. Accounts of meetings, social functions, exhibitions, chemical entertainments, etc., which might be suggestive to other organizations. Where original or unusual features are included, it is desirable that they be described in some detail.
7. Any subscriber to the JOURNAL, desiring new teaching position or seeking eligible candidate for teaching vacancy, is entitled to two free announcements yearly in this column.

Situation Wanted: Young man of 29 desires teaching position in small college or large city high school in one of the middle western states. Holds Bachelor of Science degree in chemistry, having minored in physics and mathematics. Also has 40 hours of graduate work at the State University of Iowa toward a Doctor's degree, 30 hours of which have been in physical chemistry and research. Eight years of high-school teaching experience in three states, the last five years having been spent in present position. Would prefer position of teaching general chemistry with qualitative and quantitative analysis, but could also handle organic chemistry. Reason for desiring change is to secure a better position. Married. Methodist. Mason. Perfect health. For more details concerning qualifications, write RICHARD A. WORSTELL, Head of Science Department, Fort Madison, Iowa.

American Association for the Advancement of Science. *Science Service* reports that one of America's leading authorities in experimental biology, PROF. THOMAS HUNT MORGAN, of the California Institute of Technology, has been elected president of the A. A. A. S.

Prof. Morgan's election adds to his list of honors conferred in recognition of his brilliant experimental studies, particularly in the field of heredity. He has been president of the National Academy of Sciences since 1927. He is a member of many learned societies in this country and abroad, and holds doctorate degrees from Edinburgh and McGill as well as from The Johns Hopkins University and the Universities of Michigan and Kentucky.

Prof. Morgan is best known for his discoveries regarding the laws and mechanisms by which hereditary characters are transmitted. Dealing with the factors known as genes within minute chromosomes in plants and animals, he has studied the arrangement of these factors, their nature, and their relation to one another. His experiments have shown that changes within the tiny chromosomes link with changes in hereditary characters. Prof. Morgan's most recent books deal with this problem of the physical basis of heredity.

The prize of $1000 awarded annually by the A. A. A. S. was won this year by PROFESSOR A. J. DEMPSTER, of the Ryerson Physical Laboratory of the University of Chicago. *Science Service* quotes the

following as Professor Dempster's account of the work for which the prize was given him:

"Knowledge of the nature of matter is the object toward which physicists are striving in such experiments as the one that I presented before the American Association for the Advancement of Science at its recent meeting. The physicists have already found that neutral matter is made up of positive and negative parts, and my experiments deal with the behavior of positive parts of hydrogen atoms when allowed to fall on a crystal. Hitherto experiments have indicated that these positive rays behaved as charged particles but my experiments show that they also have a wave nature. This is revealed by the complex way in which they are deflected by the crystal.

"My experiments form a counterpart to the experiments of Davisson and Germer which dealt with the wave nature of the electrons and show the wave nature of the positive part or nucleus of the atom. At present we think of all chemical atoms as built upon hydrogen nuclei and the nature of the fundamental building block is of great interest in connection with the phenomenon of radioactivity and atomic transformation in general. Its bearing on the theory at present is connected with the development of wave mechanics in that it provides a phenomenon which must be taken account of by that theory.

"The French physicist, DE BROGLIE, who has just been awarded the Nobel Prize, was the pioneer in the formulation of wave mechanics and my experiment is a proof of some of the phases of that theory. Theories in physics, as elsewhere, must check with concrete phenomena, otherwise they grow too vague.

"The German physicist, LAUE, made important studies of the structure of crystals in 1911 and these were the beginning of much of the present work in physics. He found that crystals could be considered to have a regular arrangement of molecules which acts like the structure of a silk umbrella when looked through at a distant light, diffracting the light. This was the first real evidence that X-rays were of a wave nature. My experiments have now shown that the same crystal arrangement acts in an analogous way on streams of positive hydrogen atoms indicating that they also have a wave structure."

The Perkin Medal. The Perkin Medal meeting of the Society of Chemical Industry, American Chemical Society, Societé de Chimie Industrielle and American Electrochemical Society was held on January 10th. An informal dinner preceded the meeting.

The following program was presented in Rumford Hall of the Chemists' Club at 8:15 P.M. "Early Days of the Medallist"—JAMES T. PARDEE; "Accomplishments of the Medallist"—E. O. BARSTOW; "Presentation of Perkin Medal"—MARSTON T. BOGERT; "Acceptance Speech"—HERBERT H. DOW.

Tenth Annual Ohio State Educational Conference. Thirty-two well-known speakers have already been secured for the Tenth Annual Ohio State Educational Conference, April 3, 4, 5, 1930, at The Ohio State University. Half as many more are to be secured. A list of the speakers thus far engaged follows:

H. H. BARROWS (University of Chicago), "Geography and the Individual."

SCOTT BERRY (University of Michigan), Special Education.

WILLIAM BETZ (Rochester Public Schools, New York), Junior High School Principals, "The Cultural Significance of Mathematics in the Junior High School," also in the Mathematics Section.

F. G. BONSER (Columbia University), Industrial Arts and Vocational Education, "The Consumer's Purpose in Vocational and Practical Arts Education;" High School Principals, "Is Secondary Education Possible and Desirable for Everyone?"

ROLLO BROWN (Cambridge, Massachusetts), Art.

PAUL A. CARLSON (Whitewater, Wisconsin), Commercial Education, "Tests and Measurements."

MORSE CARTWRIGHT (American Association of Adult Education), Adult Education.

ARTHUR COMPTON (University of Chicago) Non-Biological Science.

ELLWOOD CUBBERLEY (Stanford University), County Superintendents, "Fourfold Nature of the Superintendent's Work;" City Superintendents, "Three Key Problems of the Teaching Profession."

W. C. CURTIS (University of Missouri), Biological Science.

N. L. ENGELHARDT (Columbia University), Village and Consolidated School Superintendents, "How to Improve the Administration of Schools;" School Business Officials, "The School Business Official as an Educator."

LUCILE F. FARGO (School Library Adviser, temporary, Akron, Ohio), School Librarians, "Preparation for School Librarianship."

H. L. HARRINGTON (Detroit Public Schools), Junior High School Principals, "The Ideal Mechanical Organization of the Junior High School."

JESSIE HARRIS (Peabody College), Home Economics.

JAY WILLIAM HUDSON (University of Missouri), Music.

ROBERT M. HUTCHINS (President, University of Chicago), General Session.

HENRY JOHNSON (Columbia University), Social Studies, "Making History in School Historical;" Elementary Teachers, "The New History in Education."

A. J. KLEIN (U. S. Bureau of Education), Higher Education, "Coöperative Experimentation in Higher Education."

HARRY KURZ (Knox College), Modern Language.

MARK A. MAY (Yale University), Religious Education, "Some Scientific Aspects of Character Education;" Educational and Intelligence Tests, "Character and Personality Tests."

ELTON MAYO (Harvard University), Attendance Supervisors, School Nurses, and Visiting Teachers, "Psychology in Industry;" Clinical Psychology, "The Work of Jean Piaget."

EMMA GRANT MEADER (Russel Sage Foundation), Kindergarten, "Speech Difficulties and Personality Adjustments of School Children;" also in Elementary Teachers' section.

J. H. NEWLON (Columbia University), City Superintendents, "The Work of the School Executive;" also in Elementary Principals' section.

TERRY RAMSAYE (New York City), Visual Education.

HAROLD O. RUGG (Columbia University), Teacher-training.

WILFRED SHAW (University of Michigan), Adult Education.

ESTHER SHERMAN (Detroit Board of Education), Physical Education.

FRANK SOHN (Vitrolite Company, Chicago), Art.

E. H. SOTHERN (Dramatist), General Program, "Readings from Shakespeare;" English, "Great Actors and Actresses of the Past."

LEVERING TYSON (Columbia University), Adult Education.

RAY LYMAN WILBUR (Secretary of the Interior), General Session (Tentative).

BEN D. WOOD (Columbia University), Higher Education, "Watch the Individual Grow;" Educational and Intelligence Tests section.

See also **The Ohio State University.**

Brown University. DR. CHARLES KRAUS is on a tour of parts of the Middle West and the Pacific coast. He will visit a number of educational institutions and address A. C. S. groups. He expects to return to Providence about the middle of April.

DR. E. K. STRACHAN addressed the Boston Electroplater's Society on Friday, January 10th.

Nineteen graduate students are enrolled in the chemistry department of Brown University, six of whom hold assistantships

and the remainder fellowships or scholarships. The fellowships and scholarships are as follows: *du Pont Fellowship:* J. E. SMITH, B.S., University of Chattanooga, 1927; Sc.M., Brown, 1928. *Jesse Metcalf Fellowships:* G. K. TEAL, A.B., Baylor, 1927; Sc.M., Brown, 1928. *Herbert W. Rice Fellowship:* C. S. SHERMAN, Sc.B., Brown, 1927; Sc.M., Brown, 1928. *University Research Fellowships:* W. K. NELSON, Ph.B., Brown, 1925; Sc.M., 1927. F. C. SCHMIDT, Sc.B., Brown, 1927; Sc.M., 1928. R. A. VINGEE, B.S., Hobart, 1926; Sc.M., Brown, 1929. P. B. BIEN, Ph.B., Brown, 1928; Sc.M., Brown, 1929. E. G. JOHNSON, A.B., Kalamazoo, 1928; Sc.M., Brown, 1929. H. ROMEYN, A.B., Univ. of Utah, 1929. *University Graduate Scholarships:* S. N. GLARUM, A.B., Kalamazoo, 1929. O. N. HILLMAN, A.B., Clark, 1929. H. P. SMITH, A.B., Brown, 1929. F. E. TOONDER, A.B., Kalamazoo, 1929.

Those holding assistantships are: *Graduate Assistantship in the Newport Rogers Laboratory:* E. A. FLOOD. *Assistants in Analytical Chemistry:* O. C. BACON, E. W. LAWRENCE. *Assistants in Organic Chemistry:* J. F. RYAN, F. B. SMITH, J. F. WHITE. *Assistant in Physical Chemistry:* G. S. HOOPER.

The activities of the Chemistry Club of Brown University included the usual autumn department picnic and the annual graduate-undergraduate football game; the opening of the Clubroom with appropriate ceremonies; two regular meetings, at one of which PROFESSOR W. A. NOYES, JR., a recent addition to the staff, departed from chemical themes and described the conditions of post-war study in foreign universities.

Among the visitors who have spoken at various times in the laboratory are PROFESSORS RODEBUSH of Illinois, LAMER of Columbia, COWGILL of Yale, and DR. DAVIDSON of the Carbide and Carbon Chemicals Corporation.

The chemistry department furnished the program for one of the regular meetings of Sigma Xi, on which occasion PROFESSOR KRAUS outlined the aims and progress of the department, PROFESSOR NOYES discussed the characteristics of certain solid decompositions, and PROFESSOR RAKESTRAW spoke on the contributions of chemistry to the science of oceanography.

The work of the graduate division, materially strengthened by the advent of Professor Noyes, has been progressing more rapidly than ever. Professor Kraus, who has been giving regular lectures at Harvard in addition to a heavy schedule at Brown, has completed plans for an extensive speaking tour through the central and western part of the country during the next few weeks.

This year has also seen several modifications and improvements in the curriculum for the degree of Bachelor of Science in chemistry, which have raised the standards for this degree to the highest of any baccalaureate degree granted by the University. This curriculum has proved increasingly attractive during the several years it has been offered.

Carnegie Institute of Technology. Graduate courses leading to the doctors' degree in metallurgy will be offered by the department of mining and metallurgy at the Carnegie Institute of Technology beginning next fall, PRESIDENT THOMAS S. BAKER has announced. The new course had its origin in the belief on the part of Carnegie officials that there is an acute need for a more comprehensive study of the science of metals; that theoretical knowledge has lagged far behind the demands of industry.

The present research laboratories at Carnegie will be at the disposal of the students under the supervision of a competent teaching staff. Particular emphasis will be placed on the study of special steels about which knowledge is now lacking. As the work progresses it is proposed that the students will make detailed studies of mills where specialized products are manufactured.

The course of study has been outlined by

DR. V. N. KRIVOBOK of the Bureau of Metallurgical Research, Carnegie Institute of Technology, whose work in steel research has attracted wide attention. The proposed advanced study program will include such courses as advanced metallurgy of iron and steel, corrosion of metals, advanced X-ray analysis, advanced electrochemistry and electro-metallurgy, economic metallurgy, plant problems, refractories, physical chemistry of iron and steel making, metallurgical design, and advanced testing of materials.

The work will be given by the department of mining and metallurgy of which PROFESSOR JAMES ASTON is head, assisted by the Bureau of Metallurgical Research which DR. FRANCIS M. WALTERS, JR. directs.

Carnegie has conducted graduate work in metallurgy for a number of years but the master's degree was the highest award made. Each year ten such fellowships are offered by the institution in coöperation with the United States Bureau of Mines and the Advisory Board representing the steel industry. Forty-six bulletins reporting these studies have been published and distributed.

Cleveland College. *See* **Western Reserve University.**

College of the City of New York. The members of the combined staffs (Main, Brooklyn, and 23rd Street) of the department of chemistry have formed a seminar group. The first meeting was held on Friday evening, January 3rd, at the Main Center. DR. LEO LEHRMAN, '21, presented a summary of his investigations and other related work on the nature and amount of fatty acids found in starches, a subject in which he is still doing research.

The following talks during the spring term of 1930 have been arranged: *February 28th*—"Recent Advances in the Study of Atomic Structure," S. BRADFORD STONE. *March 28th*—"Smit's Theory of Allotropy," ALEXANDER LEHRMAN. *May 16th*—"Mathematics and the Theory of Chemistry," MARTIN MEYER.

During the past term DR. CASIMIR FUNK and PROFESSOR C. P. SHERWIN of Fordham University, and PROFESSOR W. H. EDDY of Columbia University addressed the students in biochemistry.

Columbia University. At the third Symposium on Organic Chemistry held at Princeton University, PROFESSOR BOGERT delivered an address on "The Organic Chemistry of the Musks."

PROFESSOR V. K. LAMER addressed the Rhode Island Section, A. C. S., on "Solutions of Electrolytes," on January 10th; and the seminar group of Brown University on January 11th, on the subject of "The Higher Terms in the Debye-Hückel Theory, and Its Application to Aqueous and Non-Aqueous Solutions."

Cooper Union. One hundred and fifty graduate engineers employed in the chemical industries have enrolled in the free evening course in physical chemistry inaugurated by the Cooper Union Institute of Technology as a practical experiment in "education for the educated," according to an announcement by DR. ALBERT B. NEWMAN, director of the chemical engineering department at Cooper Union.

The members of the class hold degrees from sixty-five different institutions of college rank in the United States, England, Canada, Norway, Sweden, Germany, Austria, and South Africa. All but two have bachelor's degrees. Fifteen have master's degrees, and four the doctor's degree.

Practically without exception, Professor Newman said, the men have been successful in their fields, managers and directors of industrial laboratories, department heads, and research executives being well represented in the enrolment.

The students are engaged in diversified industries. Chemical manufacturing, petroleum refining, electrical and electrochemical industries, metallurgy, the textile trade, and food products are among the

general groups which have substantial representation.

A majority of the men are engaged in research. Many others are applying the results of research to the design of equipment for improved operating processes. Some are research executives and managers.

Professor Newman lectures to the class on the application of graphical calculus to practical problems in physical chemistry. Under JAMES COULL, in charge of instruction in physical chemistry at the Union, systematic study of physico-chemical problems is being pursued.

Professor Newman announced that next fall his department is planning to follow the first-year course, which will be completed in March, with a new evening course in the unit operations of chemical engineering, embracing a study of the underlying theory of the flow of fluids, heat transmission, fractional distillation, drying, evaporation, extraction, and absorption.

Cornell University. The holder of the George Fisher Baker Non-Resident Lectureship in Chemistry during the current term is DR. KASIMIR FAJANS, professor of physical chemistry in the University of Munich. Professor Fajans was born in Warsaw, Poland, in 1887. He pursued his university studies at Leipzig and Heidelberg in Germany, at Zürich, Switzerland, and Manchester, England. From 1911 to 1917 he occupied the position first of assistant and later of instructor in the Technical School in Karlsruhe. In 1917 he went to the University of Munich as associate professor of physical chemistry and was advanced to the full professorship in that subject in 1925.

He formulated the displacement rule governing radioactive transformations and discovered the radioactive element brevium, now termed uranium X_2. His outstanding publications, which have brought him international reputation, have dealt with thermo-chemistry, the theory of solutions, and the theory of chemical forces in atomic structure. His book on radioactivity, which has been translated into English, is a clear and authoritative presentation of this subject.

He is a member of the Bavarian Academy of Sciences, Corresponding Member of the Academy of Sciences of Leningrad, Honorary Member of the Chemical Society of Karlsruhe, Honorary Member of the Spanish Society for Physics and Chemistry, and Honorary Member of the Society of Doctors in Madrid.

His lectures before the department of chemistry during the coming term will deal with four separate topics: (I) Radio Elements and Isotopes. (II) Chemical Linkage in Relation to the Structure of Atoms and Crystals and to the Optical Properties of Substances. (III) Strong Electrolytes. (IV) Adsorption of Ions by Salt-Like Compounds and Its Photochemical and Analytical Applications.

Professor Fajans delivered a popular introductory lecture on February 12th on "The Development of Views Regarding the Nature of Chemical Forces."

Georgetown University. The first public meeting of the Chemistry Academy was held Tuesday evening, December 10th. The guests and members had the opportunity of hearing an address on "The Relation of Chemical Research to the Various Industries," delivered by DR. HARRISON E. HOWE, editor of *Industrial and Engineering Chemistry*.

The motion pictures which have been exhibited thus far this season are "The Story of Oil," "The Story of Sulfur," and "The Story of the Mining and Preparation of Coal."

Haverford College. Arrangements have been made for the addition of two half-time assistants to the present staff of the chemistry department. They will receive $700 a year and will be permitted to work for the A.M. degree. Appointments for next year will be made early in April.

Iowa State College. The midwest regional meeting of the American Chemical Society was held as a joint meeting of Section C of the A. A. A. S. on December 27th and 28th. Approximately 250 people attended these meetings.

The following program was presented.

1.30 P.M., *December 27, 1929*

GENERAL MEETING

Banquet Room, Hotel Fort Des Moines

C. H. BAILEY, *chairman*
J. A. WILKINSON, *secretary*

Symposium on "Teaching General Chemistry," conducted by NEIL E. GORDON.

"Some Obstacles Encountered in the Teaching of High-School Chemistry," RICHARD A. WORSTELL.

"An Attempt to Motivate the Teaching of High-School Chemistry," NEIL LUTES.

"The Teaching of Chemistry in the Junior College," L. L. MINOR.

"A Survey of Chemistry as Taught to Agricultural Students," JAMES E. WEBSTER.

"The Function of the College in the Training of the Chemist," WM. M. BLANCHARD.

"Some Observations on Student Difficulties in the Study of General Chemistry," WILLIS J. BRAY.

"Possibilities of Talking Movies in Chemical Education," NEIL E. GORDON.

10.00 A.M., *December 28, 1929*

S. C. LIND, *vice-president*, Section C.
J. A. WILKINSON, *acting secretary*

GENERAL MEETING

Engineering Hall, Iowa State College

Address of Welcome, RAYMOND M. HUGHES, *president*, Iowa State College.

"Photographic Sensitizing Dyes of the Cyanine Series," C. E. KENNETH MEES, *retiring vice-president* and LESLIE G. S. BOOKER.

"The Chemical Uses of Agricultural Products," O. R. SWEENEY.

2.30 P.M., Symposium on "Chemical Utilization of Agricultural Products," Chemistry Auditorium

C. H. BAILEY, *chairman*

"Manufacture of Xylose," WARREN E. EMLEY.

"On the Trail of a New Source of Energy," ARTHUR M. BUSWELL.

"Studies on Cornstalk Cellulose," HENRY A. WEBBER.

"Furfural and Its Derivatives," HENRY GILMAN.

"Collection of Agricultural Materials," J. B. DAVIDSON and E. V. COLLINS.

2.30 P.M., General Papers on Chemistry, Room 181, Chemistry Building

S. C. LIND, *vice president*
J. A. WILKINSON, *secretary*

"The Decomposition of Organic Molecules," F. O. RICE.

"On the Formation of Long-Lived Active Molecules in Hydrogen Subjected to the Action of Alpha Particles," E. C. TRUESDALE.

"Calcium Equilibrium in Sea Water," HALDANE GEE.

"Generalization in Kinetics Based on the Decomposition Rate of Nitrogen Pentoxide," FARRINGTON DANIELS.

"Components of the Atmosphere in Relation to Animal Life," J. WILLARD HERSHEY.

"Sodium Aluminate in the Treatment and Control of Boiler Feed Water," G. J. FINK.

"Photochemical Condensation of Acetylene," R. S. LIVINGSTON and C. S. LIND.

"The Antilogarithm of the Specific Conductivity of Mixtures of Formic, Acetic, and Propionic Acids as a Linear Function of Their Percentage Compositions," E. E. MOORE, E. I. FULMER, and R. L. FOSTER.

"Electron-Sharing Ability of Organic Radicals," R. M. HIXON and I. B. JOHNS.

The second meeting of the Ames Section of the A. C. S. was held on Tuesday, November 27th. DR. J. J. HIN-

MAN, president of the American Water Works Assocation and assistant professor of Preventive Medicine at the State University of Iowa, addressed the meeting. His topic was "City Water as a Manufactured Commodity."

The third meeting of the Ames Section of the A. C. S. was held on January 21st. The meeting was addressed by DR. V. K. LAMER, of Columbia University, who spoke on "Reaction Velocity in Ionic Systems."

Only one degree in chemistry was awarded by Iowa State College at the close of the 1929 fall quarter, this being given to ROBERT E. FOTHERGILL, Ph.D. in organic chemistry.

New fellowships in the department of chemistry are as follows: a fellowship in organic chemistry, under DR. HENRY GILMAN, for the production of water soluble organo lead compounds; a fellowship with PROFESSOR J. H. BUCHANAN and DR. E. I. FULMER on the problem of industrial handling of honey. This is in coöperation with the department of entomology. A fellowship under PROFESSOR J. H. BUCHANAN to study methods for the examination of sewage. This is in conjunction with the Engineering Experiment Station.

The following Ames graduates in chemistry were back for the Regional meeting: CHESTER E. ADAMS, C. J. FINK, H. H. HALDEMAN, A. C. HANSON, V. S. HELLER, OTTO M. SMITH, E. R. WAFFLE, LAURA L. SMITH, MARION GRIFFITH, and LAURA FLYNN.

There have been two new appointments to the Chemistry staff this quarter: MR. ELTON R. LEWIS, of Iowa State College, and MR. S. C. MEHLTRETTER, of Brooklyn Polytechnic Institute.

DR. J. A. WILKINSON was appointed chairman of the Midwest Regional group of the A. C. S. for the coming meeting.

PROFESSOR JOHN BUCHANAN attended the meeting of the Iowa Bottlers of Carbonated Beverages which was held at Ottumwa on December 5th and 6th.

PROFESSOR W. F. COOVER visited the Earlham Junior College at Earlham, Iowa, on January 9th.

W. P. WOOD and G. E. WATSON, former chemical engineering students, are now with the Vulrox Corporation.

MR. J. H. TOULOUSE and MR. JAMES MCGLUMPHY recently made an inspection trip to the American Beet Sugar Factory at Mason City, Iowa.

During the regional meeting in Ames, sixty women attended a noon luncheon at Memorial Union. The luncheon was sponsored by Iota Sigma Pi, Sigma Delta Epsilon, and the American Chemical Society. DR. MARY RISING, of the University of Chicago, addressed the group on "The Contribution of Chemistry to Medicine."

GEORGE M. SEIDEL is now with the Vazcane Can Corporation at Havana, Cuba, working on the production of wall board from bagasse.

DR. C. S. HOLLANDER, of the Rohm and Haas Co., was a visitor on the campus on January 20th. He gave an interesting talk on industrial chemistry.

MR. R. J. BERKHEIMER, chemical engineering, '29, resigned his position with the Heavy Duty Electric Co., and is now connected with the du Pont Corporation, Belle, West Virginia. Several other Iowa State chemical engineers, including DR. D. V. MOSES, '25, C. I. LOUNSBERRY, '27, and J. I. SHEA, '29, are at Wilmington.

The American Bottlers of Carbonated Beverages Fellowship has been renewed. The fellows are J. H. TOULOUSE and J. R. HALL.

DR. HENRY GILMAN read a paper at the Organic Symposium held at Princeton University.

MISS ZELMA ZENTMIRE, M.S., '15, is now located at the Michigan State Health Laboratory, at Lansing. Her work is in the serology department.

PROF. ALEXANDER POLARKOFF, of the Mendeleieff Chemical-Technological Institute of Moscow, and J. M. BUDISH, visited the laboratories of the chemical engineering department and conferred

with DR. O. R. SWEENEY on the possibilities of the utilization of Russian agricultural wastes.

MR. CLIFFORD E. HEADINGTON has been transferred from the control to the research laboratories of the Atlantic Refining Company in Philadelphia.

DR. F. E. BROWN has been elected chairman of the Osborn Research Club for the year 1930.

DR. HERBERT OSBORN, of the Ohio State University, addressed the Osborn Research Club on the evening of January 13th. The Club is named in honor of Dr. Osborn because of his influence on research during the early years at Iowa State College.

MURRAY B. PETERSON, '29, chemical engineering, is now doing research work in problems of the laundry industry for Procter and Gamble Company, Ivorydale, Ohio.

Publications

Volumes 2 and 3 of "Physiology and Bio-chemistry of Bacteria," by R. E. BUCHANAN and E. I. FULMER will be off the Williams and Wilkins press about May first. Numerous articles by members of the staff have appeared recently in various scientific publications.

The Johns Hopkins University. The Maryland Section, A. C. S., was invited to a lecture in Remsen Hall on January 17th by DR. N. A. SHEPARD, of the Firestone Tire and Rubber Company. The lecture, which dealt with "The Rubber Industry," was illustrated by moving pictures and lantern slides.

This lecture was a popular version of a talk on the same subject, given in the afternoon of the same day, by Dr. Shepard under the Dohme Lectureship before the faculty and students of the university.

DR. J. C. W. FRAZER, chairman of the department of chemistry, has recently announced his development of a chemical device to replace mufflers on automobiles for the elimination of carbon monoxide from exhaust gases. *Science Service* gives the following account of Dr. Frazer's discovery:

"Since carbon monoxide, odorless, colorless, tasteless, and poisonous, swiftly in small concentrations claims many lives each month through the carelessness of automobilists failing to open garage doors before warming up their engines, this latest chemical achievement is hailed as an important step in making the machine age less dangerous. Dr. Frazer declared today that an automobile equipped with the new oxidizing device could be run in a closed garage without danger from carbon monoxide poisoning.

"Because of patent claims, Dr. Frazer has not yet revealed the exact nature of the material that transforms the deadly carbon monoxide to carbon dioxide, the same gas that human beings breathe out of their lungs. But it is known that it is a catalyst, a substance that causes a chemical reaction without itself participating. It is similar in action to the catalyst, consisting of manganese dioxide and copper oxide, that was an outgrowth of chemical warfare work by Dr. Frazer and a laboratory staff during the World War. Fire departments and mine rescue squads use gas masks today that rely on this wartime catalyst for purifying the air of carbon monoxide.

"For a year and a half, Dr. Frazer worked to develop the new catalyst that will add oxygen to carbon monoxide even when in direct contact with hot, moist gases. Laboratory tests and thousands of miles of road testing convince him that a canister of the catalyst substituted for the regulation muffler will not only deaden the noise of the engine explosions but remove all the unburned fuel gases in the exhaust, the ill-smelling ones as well as the deadly carbon monoxide. As about a third of the fuel is unconsumed in the engine cylinders, the small canister of catalyst has the task of burning half as much fuel as the engine does. Heat from this reaction may be utilized in some way in future installations, such as for car heating or preheating the fuel.

"At present only one experimental unit of the catalyst muffler is in operation, mounted for convenience on the running board of Dr. Frazer's experimental car. A company for the commercial exploitation of the invention is in the process of organization."

Kansas State Agricultural College. The Local Section of the A. C. S. held a joint meeting with the Science Club on January 13th, at 7.30 P.M., in the large lecture room of Denison Hall. DR. H. W. BRUBAKER, who is the newly elected chairman of both societies, gave the address of the evening. His topic was "Water Treatment and the Manhattan Waterworks Plant."

Mellon Institute of Industrial Research, University of Pittsburgh. DR. E. R. WEIDLEIN, director of Mellon Institute of Industrial Research, Pittsburgh, Penna., has announced the following appointments at that institution made between July 1, 1929, and January 1, 1930. The appointments for the first six months of 1929 appeared in the September, 1929, number of THIS JOURNAL, p. 1597.

Senior Industrial Fellows:

JAMES M. LAWRENCE (Ph.D., University of Wisconsin, 1912) has been appointed to the senior incumbency of the multiple industrial fellowship on wax. Before accepting this position, Dr. Lawrence had wide experience in several fields of chemical research, development, and administration. He succeeds DR. D. K. TRESSLER, who has joined the research staff of the General Foods Company, Gloucester, Mass.

Industrial Fellows:

HENRY A. AMBROSE (Ph.D., Massachusetts Institute of Technology, 1930) has been appointed an industrial fellow on the multiple fellowship on petroleum production. N. J. BEABER (Ph.D., Iowa State College, 1925) has been appointed to the nicotine fellowship. He was previously engaged at the Institute in research on the gum fellowship. ALEXANDER C. BROWN (M.S., Massachusetts Institute of Technology, 1926) has been added to the personnel of the multiple industrial fellowship on fatty acids. Before going to Pittsburgh, he had spent a year in Germany and two years in industrial work on petroleum. JASPER S. BROWN (B.S., University of Maine, 1926) has been appointed to the multiple fellowship on petroleum production. His previous experience was gained at the Pittsburgh Station of the U. S. Bureau of Mines. FRANK L. JONES (M.A., Columbia University, 1927) has been appointed to the enamels fellowship. Before accepting this position he was engaged in work toward the doctorate at Columbia, and he has also had teaching and industrial experience. He is succeeding B. A. RICE, who has joined the Pfaudler Company. RONALD B. MCKINNIS (Ph.D., University of Pittsburgh, 1930) has been appointed to the can fellowship. S. M. MARTIN, JR. (M.S., University of North Carolina, 1929) has joined the research staff of the multiple industrial fellowship on petroleum refining. Before going to the Institute, he had had several years' experience in rubber technology. DANIEL C. L. SHERK (Ph.D., University of Wisconsin, 1920) has been appointed to the wood by-products fellowship. He has been engaged in industrial work since receiving his doctorate. THOMAS H. SWAN (Ph.D., Ohio State University, 1924) has been appointed to the garment fellowship. Since 1924 he has been the holder of the Institute's bed fellowship. A. J. TEPLITZ (B.S., University of Kansas, 1926) has been appointed an industrial fellow on the petroleum production fellowship. RICHARD B. UNANGST (B.S., Lafayette College, 1916) has joined the personnel of the multiple utensil fellowship. Since 1916 he has been engaged in industrial work.

Promotional Changes—Fellowship Assistant to Industrial Fellow:

J. R. ADAMS (M.S., Carnegie Institute of Technology, 1929), petroleum refining

fellowship; HARRY C. DONALDSON, JR. (B.S., University of Pittsburgh, 1928), multiple fellowship on iodine; M. C. EDWARDS (B.S., Louisiana State Normal, 1928), organic synthesis fellowship; H. R. FIFE (M.S., West Virginia University, 1925), organic synthesis fellowship; R. B. FRAZIER (M.S., University of Nebraska, 1927), organic synthesis fellowship; J. A. SATOSKY (B.S., Pennsylvania State College, 1929), carbon black fellowship; CARLISLE SCHADE (B.Chem., Cornell University, 1925), wax fellowship.

Fellowship Assistants:

M. F. BENBOW, smoke fellowship; W. H. BRADLEY, utensil fellowship; HELEN BRIGHT (B.S., Carnegie Institute of Technology, 1929), varieties fellowship; RICHARD F. BROWN (A.B., Marietta College, 1929), organic synthesis fellowship; THOMAS A. CARR, refractories fellowship; ALFRED T. CLIFFORD (M.S., University of North Carolina, 1928), petroleum refining fellowship; JAMES DOHERTY, petroleum refining fellowship; HOWARD C. LAWTON (B.S., University of California, 1929), petroleum production fellowship; R. A. MACARTHUR (B.S., Massachusetts Institute of Technology, 1927), organic synthesis fellowship; DEWEY A. MILLER (B.S., Carnegie Institute of Technology, 1928), pigment fellowship; EARL C. PETRIE (B.S. in Cer. Eng., Ohio State University, 1929), refractories fellowship; ELINOR A. SACKTER (B.S., University of Pittsburgh, 1929), assistant in the Institute's analytical department; W. T. SCHELLING (B.S., University of California, 1929), petroleum production fellowship.

Ohio State University. PROFESSOR G. P. THOMSON, Aberdeen University, delivered a series of four lectures on "Electron Waves" on January 27th and 28th. The program was given under the auspices of the Columbus Section of the A. C. S., the Ohio State Chapter of the Society of Sigma Xi and the Graduate School. Professor Thomson is visiting lecturer at Cornell University.

PROFESSORS W. L. EVANS, C. E. BOORD, W. R. BRODE and DR. M. L. WOLFROM, of the department of chemistry, were in attendance at the Third Organic Symposium at Princeton University. Twenty-four of the others present at the Symposium received their Ph.D. degrees at Ohio State.

DR. M. L. WOLFROM was one of the guests of the Rockefeller Institute of Medical Research on the occasion of the dinner held in honor of DR. P. A. LEVENE on January 13th. Dr. Wolfrom did carbohydrate work under Dr. Levene's direction the year before coming to The Ohio State University.

PROFESSOR JAMES R. WITHROW, of the department of chemical engineering, addressed the officers and technical staff of the Robbins and Myers Company of Springfield, Ohio, on January 16th, on "The Chemical Industry of Ohio." Dr. Withrow also gave a radio address over WEAO on substantially the same topic on January 17th.

During the latter part of the second week of January, Professor Withrow attended the Annual Assembly of the American Engineering Council and the preliminary Administrative Board Meeting. He is completing his third term as a member of the Administrative Board of this Council, representing thereon the States of Ohio, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, West Virginia, and the District of Columbia.

MR. P. G. HORTON is the holder of the J. T. Baker Company Analytical Research Fellowship (Mid-Western Division) this year. The chemists now sitting as the permanent members of the board governing and administering the Fellowship are PROFESSORS H. H. WILLARD (chairman), C. W. FOULK, STEPHEN POPOFF, and FREDERICK G. SMITH. In awarding this Fellowship, preference is shown: (*a*) to those institutions which have a background in research in inorganic analytical chemistry; (*b*) the project sponsored by the division of analytical chemistry; (*c*) the candidates desiring to follow the teaching profession. This is in effect the

awarding of the Fellowship to the professor of analytical chemistry who in a given year has the best research project. This year the professor is C. W. FOULK. The subject of the investigation is: "A precision study of the direct absorption of hydrogen chloride in water as a means of preparing a standard acid solution."

PROFESSOR J. E. DAY, of the department of chemistry, addressed the Ohio Northern Section of the A. C. S., on January 30th on the "Catalytic Oxidation of Carbon."

PROFESSOR H. L. JOHNSTON, of the department of chemistry, gave a radio address sponsored by the Ohio School of the Air over WLW on January 14th. His topic was "Chemistry at Low Temperatures."

The tenth educational conference will be held at the Ohio State University on Friday, April 4, 1930, at 9 A.M. PROFESSOR WILLIAM LLOYD EVANS will be the presiding officer. The program of the Non-Biological Science Section is as follows:

"Matter and Energy," PROFESSOR ALPHEUS W. SMITH, Department of Physics, The Ohio State University.

"Symmetrical and Unsymmetrical Hydrogen," PROFESSOR HERRICK L. JOHNSTON, Department of Chemistry, The Ohio State University.

"An Interpretation of the New Mechanics," DR. SAUL DUSHMAN, Research Laboratory, The General Electric Company.

"What Are the Stars?" PROFESSOR H. T. STETSON, Department of Astronomy, The Ohio Wesleyan University.

"Some Applications of the New Mechanics to Physics and Chemistry," DR. SAUL DUSHMAN, Research Laboratory, The General Electric Company.

"What Is Light?" PROFESSOR ARTHUR H. COMPTON, Department of Physics, The University of Chicago.

For a partial program of the entire conference, *see also* **Tenth Annual Ohio State Educational Conference,** *p. 703.*

Roanoke College. Virginia Polytechnic Institute is planning an engineers spring conference for April.

Chemists of the vicinity of Roanoke College will meet at Washington & Lee University in March.

PROFESSOR JAS. L. HOWE, of Washington & Lee, addressed the Chemists Club on the platinum industry during a meeting at Hollins College on January 11th. He emphasized the many adaptations of platinum group metals to economic life. Chemists have used platinum in the investigations of catalysis, solubility, and thermal and electrical phenomena with a great measure of success. Limited sources and cost of platinum were mentioned as curbing factors in chemical workshops.

Rutgers University. PROFESSOR I. D. GARARD attended the convention of the A. A. A. S. at Des Moines during the Christmas vacation.

MR. A. T. HAWKINSON, who recently returned from a year of study with PROFESSOR FAJANS at Munich, has accepted a position in the research department of the Roessler and Hasslacher Chemical Company.

MR. PAUL DAUGHENBAUGH and PROFESSOR J. B. ALLISON reported in the December number of the *Journal of the American Chemical Society*, a portion of their research on the synthesis of derivatives of dextrose. This work is supported by a grant from the Johnson and Johnson Company.

DR. MAXIMILIAN TOCH lectured to the New Brunswick Scientific Society on the subject "The Scientific Investigation of Artistic Paintings."

The State College of Washington. DR. W. E. BRADT has been appointed to an assistant professorship at the State College of Washington. For the past two and one-half years he has been teaching and carrying on research in organic chemistry at the University of Cincinnati. Prior to that, he filled a

one-year interim appointment at the State College of Washington. Professor Bradt received his Bachelor's, Master's, and Doctor's degrees from Indiana University. He is a member of Phi Lambda Upsilon, Phi Beta Kappa, Sigma Xi, Northwest Scientific Association, American Chemical Society, and American Electrochemical Society.

State University of Iowa. DR. WALTER WHITMAN, of the Standard Oil Company, Whiting, Indiana, visited the university to interview chemists and chemical engineers on January 16th.

PROFESSOR EDWARD BARTOW has received notification of his election to membership in the Executive Committee of the Sanitary Engineering Division of the American Society of Civil Engineers for a five-year term beginning January, 1930.

PROFESSOR VICTOR K. LAMER, of Columbia University, visited the University on January 20th and addressed the Iowa Section of the A. C. S. on the subject "Electrolyte Solutions."

PROFESSOR L. CHAS. RAIFORD and PROFESSOR G. H. COLEMAN attended the Organic Symposium at Princeton, December 30th–January 1st.

PROFESSOR and MRS. EDWARD BARTOW report a pleasant visit to the Philippines during their trip in the Orient. They traveled on schedule in China, although some of the party were held up for several days by a mutiny. After visiting the islands of Java, Australia, and New Zealand, they will return to the United States in March.

Swarthmore College. DR. R. V. WILLIAMSON, of the Experiment Station of the E. I. du Pont de Nemours Powder Company, addressed the Chemistry Club of Swarthmore College on January 9th, on "The Structure of Colloidal Dispersions as Revealed by Their Flowing Properties."

At a meeting held at the Bureau of Standards on December 18, 1929, DR. EDWARD H. COX, associate professor of chemistry at Swarthmore College, was appointed to serve on the standing committee which will consider the Commercial Standard for Interchangeable Ground Glass Joints.

Trinity College. PROFESSORS KRIEBLE and SKAU, of the chemistry department, attended the recent Symposium on Organic Chemistry at Princeton University. Professor Krieble gave a brief resumé of his work on the hydrolysis of nitriles.

University of Alabama. The department of chemistry and metallurgy has been expanded into the school of chemistry, metallurgy, and ceramics, with DR. STEWART J. LLOYD as dean. A curriculum leading to the degree of Bachelor of Science has been added. Apparently, Alabama is the first to combine these three departments into a single group.

This expansion was necessitated by the rapid growth of the University, whose enrolment has been increasing approximately twenty per cent each year for several years. Due to the increase in students, the new chemistry building, erected two years ago, will soon prove inadequate, and will require additions within the next two years. Much new equipment has been added in the past year, especially in the department of ceramics.

During the past year PROFESSOR T. N. MCVAY, of the University of Illinois, was added as head of the department of ceramics, and DR. J. L. KASSNER, of the University of Michigan, as instructor in physical chemistry. PROFESSOR R. L. FARABEE, who had been on leave of absence at Purdue University, where he directed the department of metallurgy, returned on February 1st to take up his duties as head of the department of metallurgy. PROFESSOR JELKS BARKSDALE, who has been acting head of the department, returned to the State Geological Survey as staff geologist.

The All States Life Insurance Company of Montgomery, Alabama, has recently offered a prize of fifty dollars for

the best essay on "Chemistry and the Prolongation of Human Life." This competition is open to all students in the school of chemistry, metallurgy, and ceramics.

University of Arkansas. Inquiries concerning the Women's Club Study Course in American chemistry are being received from all sections of the United States by the chairman of the committee, DR. HARRISON HALE. This course, which was authorized by the Division of Chemical Education, American Chemical Society, at Minneapolis, is offered by the Division in coöperation with the Bureau of Women's Clubs, University of Arkansas, Fayetteville.

This is a study of the fundamental importance of chemistry in the life of America and is non-technical. It seeks to be of interest to this large group of intelligent and influential women. The outline of the course is published in full in the February, 1930, number of THIS JOURNAL, p. 325. The coöperation of chemists in bringing this to the attention of clubs in their vicinity is desired and expected.

At a recent meeting of Alpha Sigma Chapter, Alpha Chi Sigma Fraternity, it was unanimously voted to award to the most representative student a membership in the American Chemical Society under these conditions: (1) This award is to be made to one of the four best students in the senior class in chemistry or chemical engineering, who are in at least their second year's residence at the University of Arkansas, as shown by their scholastic grade point average in all work done at this university. (2) The award is to be made immediately after the close of the first semester in each year, beginning in 1931, to the one selected from the four students of highest rank. This selection is to be made by vote of the faculty and student members, each member ranking the four candidates by the numbers 1, 2, 3, and 4.

University of Chicago. In coöperation with the University College, members of the departments of chemistry and physics are giving a series of lectures during the winter months with particular reference to the "electron." The lectures are as follows:

1. "The Nature of the Electron," PROF. HOAG.
2. "The Nature of Heat, Structure of the Solid State," PROF. MONK.
3. "The Nature of Light," PROF. COMPTON.
4. "The Structure of the Atom," PROF. LEMON.
5. "Modern Theories of Strong Electrolytes," PROF. YOUNG.
6. "The Electron in Organic Chemistry," PROF. KHARASCH.
7. "The Coördination Theory of Alfred Werner," PROF. SCHLESINGER.
8. "Atomic Species, Isotopes, Radioactivity," PROF. HARKINS.
9. "Crystal Structure from the Standpoint of X-Rays," PROF. HARRIS.
10. "The Relation of Band Spectra to Chemistry," PROF. MULLIKAN.

From the issue of *Science* of January 17, 1930, we quote the following announcements:

"Plans for the development of the department of chemistry of the University of Chicago, made possible by the new George Herbert Jones Laboratory, were outlined by PROFESSOR JULIUS STIEGLITZ, chairman, at a dinner which concluded the recent dedication program. The laboratory, gift of the Chicago citizen whose name it bears, provides facilities for more than a hundred research workers in chemistry. The cost was $365,000. The Rockefeller Foundation and the General Education Board have contributed $300,000 in endowment for the development of the staff of the department and for the purchase and maintenance of equipment necessary for their research work. In addition, The Chemical Foundation appropriated the sum of $10,000 a year for five years for research in chemistry applied to medicine. Pierre S. du Pont has given $10,000 a year for two years, to be expended in research in

cancer from the chemical end, under the direction of ASSOCIATE PROFESSOR MORRIS KHARASCH. Strengthening of the staff, in anticipation of the improved opportunities afforded by the new laboratory, has already been achieved. Dr. Kharasch, of the University of Maryland, was brought to the University of Chicago a year ago. On January 1st, PROFESSOR T. R. HOGNESS, of the University of California, joined the staff as a permanent member. He will enable the department to develop more rapidly and intensively the application of light to the solution of chemical problems, especially those in connection with molecules and atoms. DR. PRESTON HARRIS, at present of the department of physics, will join the staff in the spring quarter. His field of research is the application to chemical problems of the X-ray."

University of Maryland. The department of chemistry of the University of Maryland wishes to announce that the lecture courses, which have been given on Tuesday and Thursday evenings in Baltimore, are being continued for the second semester.

The course offered is advanced physical chemistry and will be the equivalent of four university graduate credits.

Though of graduate credit grade, the course is open to any student having the necessary prerequisites who desires an opportunity for advanced study.

University of Missouri. DR. HERMAN SCHLUNDT, chairman of the department of chemistry, attended a conference of radioactivity experts, which was held in New York City, January 17, 1930. The subject of the conference was radium poisoning.

University of Nebraska. DEAN F. W. UPSON, representing the alumni of the University of Chicago, presented the bronze of the late DR. J. U. NEF at the dedication of the new Jones Laboratory at the University of Chicago, December 16th. Dr. Upson, who had his work with Dr. Nef, is chairman of the department of chemistry at Nebraska University, and dean of the graduate school. In addition to his executive work, he directs the research of a group of graduate students in chemistry, and gives graduate courses in organic chemistry.

DR. H. G. DEMING'S newest book will appear in February or March. The title, "In the Realm of Carbon," suggests the nature of the work. Those who have seen the book in the making say that it is an interesting contribution to the current scientific literature, discussing as it does the growth of organic chemistry and its present application in industry and life.

Dr. Deming is a professor of chemistry at the University of Nebraska, having returned this year after a leave of absence spent with the Arthur D. Little Co.

The November issue of *School Science and Mathematics* contained suggestions for the high-school chemistry library. A question, "I have been allowed one hundred dollars for use in obtaining some desirable chemistry books for our high school library. Can you give me some help in finding those books?" prompted the article. The authors are MISS MURIEL C. GERE, Lincoln Senior High School; J. J. GUNTHER, Omaha Technical High School; and B. CLIFFORD HENDRICKS, University of Nebraska. Dr. Hendricks, who is associate professor of chemistry, devotes himself also to the teaching aspect of chemistry, giving courses in the teaching of chemistry during the year.

PROFESSOR C. J. FRANKFORTER addressed the State Fireman's Meeting, January 21st, on the subject "Fires and Fire Extinguishers." Professor Frankforter is in charge of the courses in engineering chemistry at Nebraska. He has recently been appointed chairman of the Engineering Inspection Trip Committee which will have charge of the annual inspection trip of the Engineering College students. This trip will cover the Chicago district during the week of next Easter recess. On December 10th, Professor

Frankforter spoke before the Omaha Section of the A. C. S. on "Some Phases of Chemistry in the Petroleum Industry," and on December 19th he gave a lecture and demonstration on "Explosives" before the Gage County Reserve Officers Association at Beatrice, Nebraska.

The Nebraska Chemistry Colloqium, which reorganized during November, has as its officers, MR. HOWARD T. BONNETT, *chairman;* and MR. VINCENT HNIZDA, *secretary.* Officers are reëlected quarterly. Speakers thus far have been: DR. F. W. UPSON, "Graduate Work in Chemistry;" PROFESSOR C. S. HAMILTON, "Medical Uses of Arsenicals;" and MR. ALBERT LIGHTBODY, "The Change of Physical Properties on Intensive Drying."

The Nebraska Section of the A. C. S. was addressed on January 22nd by DR. V. K. LAMER of Columbia University. Dr. LaMer's subject was "Solutions." Preceding the meeting Dr. LaMer and the faculty of the department of chemistry were entertained at dinner at the Alpha Chi Sigma house.

DR. S. C. LIND, director of the school of chemistry at the University of Minnesota, addressed the Nebraska Section on February 11th on the subject, "The Contributions of Radioactivity to Science."

The University of Vermont. An attempt is being made this year to adapt the same fundamental course in introductory chemistry to students of varying attainment, ability, and industry. As is not unusual, all students of the course attend each week three classroom exercises, in sections made as small as available instructors permit, and two two-hour laboratory exercises. Each month the sections are brought together and given a uniform test. Those who fall below the passing grade in any of these tests are required to attend an additional classroom exercise each week through the following month. The passing of a subsequent uniform test frees a student of this obligation, until further possible misfortune. The additional exercise gives added opportunity to students to whom the course seems discouragingly difficult, and affords an obvious incentive to those of lesser earnestness and diligence. Students who are not failing may attend the extra classes, and from time to time a considerable number do this.

University of Virginia. DR. H. E. HOWE, editor, *Industrial and Engineering Chemistry,* and member of the American Institute of Chemical Engineers, was the principal speaker and guest of honor at the first meeting of the recently formed Chemical Engineering Society at the University of Virginia. Over one hundred students and faculty members heard an exposition of "The New Engineering Profession," in the course of which the speaker demonstrated the service of the chemical engineer to the society by citing innumerable examples of technical achievement ranging from bakelite to synthetic fertilizers. Engineering was defined as the application of technical information to commercial processes, and the chemical engineer specifically as the man who applies not only chemical data to commercial processes, but engineering data as well. Progress in the engineering profession was emphasized by such comparisons as the construction of the ancient Roman aqueduct in 30 years with 1000 men, while now 100 men aided by modern explosives could do the same work in 10 months; or again, the blowing of glass blanks for electric light lamps or radio tubes, formerly a slow and exhaustive one-man job, now replaced by machines capable of blowing 30,000 per day. The marvels of modern alloys were submitted as further examples of recent advances aided by chemistry and chemical engineering. Among these are noted permalloy, rendering transatlantic telephony practicable, carboloy and resultant high speed machine production, and duralumin and "alclad" in the construction of dirigibles and planes.

University of Wisconsin. DR. CLARENCE MUEHLBERGER, state toxicologist

and assistant professor of toxicology, will leave the University of Wisconsin on March 1st to assume his duties as assistant director of the Scientific Crime Detection Laboratories established in affiliation with Northwestern University.

Washington University. DR. L. E. STOUT, associate professor of chemistry, has been conducting the educational division for the St. Louis Section of the American Electroplaters Society during the past two years.

DR. J. H. GARDNER, associate professor of chemistry, attended the Organic Symposium at Princeton University during the Christmas holidays.

DR. ALEXIS E. CHICHIBABIN, dean of the chemical faculty, Polytechnical Institute, Moscow, U. S. S. R., visited the department of chemistry last fall while in this country.

New chemical engineering equipment added during the current year includes a Sharples supercentrifuge and an Ansonia column still. Considerable new physical chemistry equipment has also been installed.

The November meeting of the St. Louis Professional Chapter of Alpha Chi Sigma is known as the Freshman Award Meeting, due to the fact that the honored guests at that meeting are the two freshman students of chemistry who received the highest grades from Washington University during the preceding academic year. These two students, one from the school of engineering and one from the college of liberal arts, are formally notified at this meeting that their ability has been recognized by Alpha Chi Sigma and that they are to be rewarded by having their names engraved on the Alpha Chi Sigma Tablet in the library of the department of chemistry, Washington University. The recipients of this honor for last year were MISS CAROLYN L. BACHER and WILLIAM K. MENKE. For the first time since the erection of the tablet the name of a young lady will appear thereon this year.

Wesleyan University. PROFESSOR J. E. CAVELTI addressed the Exchange Club of Middletown on January 2nd, discussing "The Size of Things."

PROFESSOR G. ALBERT HILL has accepted an appointment to the Board of Examiners in chemistry for the College Entrance Examination Board. He was a member of the committee which had charge of the Colloquium on the Mechanism of Organic Reactions at the recent Symposium held at Princeton, and in this connection presented a paper on "Hydrolysis."

At the meeting of the Atwater Club, held in Middletown on January 6th, Professor Hill spoke on the subject of "Dollars from Dump Heaps."

PROFESSOR C. R. HOOVER addressed the Rotary Club in Waterbury, January 7th, on the subject of "Modern Gasolines."

Western Reserve University. The du Pont de Nemours Co. has established, in the Graduate School of Western Reserve University, a scholarship on behalf of the Grasselli Chemical Co. of Cleveland, the stipend of which is $500. In addition there are available a number of fellowships ranging from $500 up to $1500 per year, and graduate assistantships up to $800 per year.

In addition, the University grants eight fellowships of $500 each for graduate study. The graduate assistantships require about 15 hours of the students' time a week, yielding a stipend of $750–800 for the college year with partial free tuition.

The above fellowships require no teaching but the fellows' entire time must be devoted to graduate study, with one month's vacation in August. Fellows to be appointed now will be expected to begin study June 24th for one year.

These graduate appointments are open only to graduates of accredited colleges. Applicants should present an official transcript of previous study both undergraduate and graduate, and a recent photograph with his application, and

have sent direct sealed letters from qualified persons indicating his character, health, ability, and accomplishments to the dean of the graduate school. Appointments will be made March 1, 1930.

This semester Cleveland College and the graduate school of Western Reserve University are offering evening courses in both elementary and advanced chemical microscopy, chemistry applied to industry, and research in chemistry. A graduate degree, either A.M., or Ph.D., is obtainable in these evening courses.

The microscope is now becoming known for its value as a research tool. By the methods of microqualitative analysis the nature of tiny particles can be determined in one-tenth the time of the usual methods. The students in the course in chemical microscopy are taught to apply the microscope and its accessories to research in general and also to their own problems as far as possible. The course is fully equipped with chemical microscopes, photomicrographic apparatus, ultramicroscopes, a fluorescence microscope, and all the numerous accessories of the microscope.

The course in Chemistry Applied to Industry covers the application of chemistry to the needs of the plant manager, designing engineer, architect-builder, and general manufacturer. Among the topics covered are water, fuels, and lubricants, materials of construction, cleansing agents, protective coatings and corrosion, cutting and welding, heavy chemicals, etc.

The Cincinnati Section, A. C. S. The 311th meeting of the Cincinnati Section of the A. C. S. was held in the auditorium of the chemistry building of the University of Cincinnati on January 8, 1930, at 8.00 P.M.

The speaker for this meeting was MR. A. F. WENDLER, Chief Supervisor Operating Control and Assistance Section at the Buffalo Plant of the du Pont Rayon Company. Mr. Wendler addressed the Section on the topic "Rayon—The New Influence in Textiles."

Columbus Section, A. C. S. *See* **The Ohio State University.**

Iowa Section, A. C. S. *See* **State University of Iowa.**

Kansas Section, A. C. S. *See* **Kansas State Agricultural College.**

Lehigh Valley Section, A. C. S. DR. EDWARD HART, professor emeritus of analytical chemistry at Lafayette College was honored recently by a dinner given by the Lehigh Valley Section of the A. C. S. During his remarks at the dinner, Dr. Hart reviewed the development of metallurgy in the Lehigh Valley and mentioned particularly the part played in that development by one of his own pupils, JAMES GAYLEY. Dr. Hart, who celebrated his seventy-fifth birthday last November, was formerly editor of the *Journal of Analytical and Applied Chemistry* and of the *Journal of the American Chemical Society*.

Maryland Section, A. C. S. *See* **The Johns Hopkins University.**

Nebraska Section, A. C. S. *See* **University of Nebraska.**

Northern West Virginia Section, A. C. S. On the evening of January 15, 1930, DR. OLIVER KAMM, research director for Parke, Davis and Company, addressed the Northern West Virginia Section of the A. C. S. The subject of his address was "The Alpha and Beta Hormones from the Posterior Lobe of the Pituitary Gland."

Dr. Kamm was the recipient of the $1000 prize of the American Association for the Advancement of Science for the year 1928.

Ohio Northern Section, A. C. S. *See* **The Ohio State University.**

Rhode Island Section, A. C. S. *See* **Columbia University.**

Syracuse Section, A. C. S. The Syracuse Section of the A. C. S. has been affiliated with the Technology Club of

Syracuse for the past two years. The affiliates of this club are the American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Society of Civil Engineers, American Association of Engineers, The National Association of Power Engineers, and the Syracuse Architects Club. The Club meets regularly each Monday evening at the Onondaga Hotel roof garden, when papers by the various organizations are presented.

Isotope of Carbon. Carbon is the latest chemical element to be shown to have a twin. Last winter two California physicists showed that oxygen, long supposed to be single, was not only double, but triple. Now Dr. Arthur S. King, of the Mt. Wilson Observatory, and Dr. Raymond T. Birge, of the University of California, have found a kind of carbon that is heavier than the ordinary form. Carbon is one of the most essential elements in living matter.

These experimenters heated carbon in a vacuum in an electric furnace to a temperature around 5000 degrees Fahrenheit. When the light that it emitted was analyzed with a spectroscope, the usual bright bands of the spectrum appeared, including a very prominent red one. Close to this, however, the photographs showed another, very faint, and previously unknown.

Ordinary carbon is of mass 12, in the scale used for measuring the mass of the atoms. Dr. King and Dr. Birge announce that the new band can be explained by the presence along with ordinary carbon of another kind, or isotope, of mass 13. They are unable to estimate the relative proportions of the two kinds, but the heavier isotope must be present in very small quantities, for the band is hundreds of times as faint as the strong one.

Isotopes, or forms of the same element having different weight atoms, were first discovered in connection with studies of radium and similar elements. A few years ago Dr. F. W. Aston, an English scientist, proved that a number of common elements consisted of as many as six or more isotopes. Last year Dr. W. F. Giauque and H. L. Johnstone, of the University of California, following up a lead given by Dr. King, showed the existence of three oxygen isotopes, weighing 17 and 18, as well as the ordinary kind, weighing 16.—*Science Service*

Beryllium Foreseen as Aircraft Metal. Beryllium, a light metal now worth $200 a pound, is likely to find commercial utilization in future aircraft construction, Dr. W. H. Gillett, director of the Battelle Memorial Institute, Columbus, Ohio, predicted in a report to the American Electrochemical Society.

Although now in the rare metal class, beryllium, on account of its light weight, a third that of aluminum, would allow decreases in the weight of aircraft. Designers have estimated that it is worth $40 to reduce the weight of an airplane one pound.

Rare as the metal is today, Dr. Gillett declared it could be obtained in quantity and at a price of about $25 to $50 a pound if there was demand for it. Geologists estimate that there is as much beryllium by weight in the earth's crust as there is lead or zinc, and much more by volume.

Due to its present high cost, little is known about beryllium's ease of fabrication and endurance. It is known to have a higher modulus of elasticity than other light metals and this property, nearly equal that of steel, promises to allow aircraft designers to use methods of construction not now possible.

Dr. Gillett declared that aircraft producers interested in a new material would do well to make a thorough investigation of this metal about which little is now known.—*Science Service*

Recent Books

A Chemical Dictionary. INGO W. D. HACKH, Professor of Chemistry, College of Physicians and Surgeons, San Francisco, California. P. Blakiston's Son and Co., Inc., Philadelphia, Penna., 1929. viii + 790 pp. 17 × 25 cm. 232 illustrations, including 58 photographs of noted chemists and physicists. $10.00.

In his attempt to produce a comprehensive chemical dictionary, which should not only give pronunciations and definitions of words but illustrate the same, wherever possible, the author has succeeded very well. A large proportion of the illustrations are those of laboratory apparatus but there are numerous sketches, curves, graphic symbols and formulas, tables, etc. On the whole the illustrations are excellent. This feature, in the reviewer's opinion, constitutes the most valuable phase of the book.

To present the photographs of prominent persons is not only an admirable and deserved recognition to those who have materially helped to expand the boundaries of the science, but is a stimulus to achievement. A great many names of notable chemists and teachers of chemistry are listed, whose photographs are not shown. Just why the author did not include some of the following, is known only to himself: Charles M. Hall, T. B. Osborne, Olaf Hammarsten, Richard Willstätter, C. S. Hudson, F. A. Gooch, Victor Grignard, J. Lewkowitsch, Edgar F. Smith, S. G. Hedin, The Svedberg, J. W. Mellor, Harvey W. Wiley, James F. Norris, Emmet Reid, Hugh S. Taylor, and many others whose contributions to chemistry are certainly of equal if not higher rank than those of some of the men there found. Emil Abderhalden is listed as a German chemist, and Henry D. Dakin as English. Photographs of Paul Sabatier and Alfred Werner are interchanged.

By counting the number of words on representative pages it is estimated that the book contains between 25,000 and 30,000 words, a great number of which are from other branches of science, and some have only the remotest connection with chemistry such as: old age, oak, onion, olive, ration, mist, magnify, pencil, etc.

On the whole the definitions are short, clear, and accurate, but a few were found that seem to require revision, for example: "**absinthe** (*ab'-sinth*) Same as absinthium. **an oil.** Same as wormwood oil." The latter is not listed. Absinthium is a certain part of an herb. Absinthe is usually known as a bitter alcoholic liquor used mostly in France and Switzerland. "**Turnbull's blue.** Insoluble Prussian blue. $Fe_4(FeC_6N_3)$. A deep blue precipitate, lighter than Prussian blue, obtained from excess of a ferrous salt and a solution of potassium ferrocyanide. It was formerly considered to be ferrous ferrocyanide."

The following three words are quoted to emphasize the need of a more uniform nomenclature: "**fluosilicic acid.** (*floo-o-sil-is'-ik*). $H_2SiF_6 = 144.3$." "**hydro-fluosilicic acid** (*hi-dro-floo-o-sil-is'ik*) H_2SiF_6 — 144.1. Silicofluoric acid, hydrosilicofluoric acid. An acid known only in solution, etc." "**hydrosilicofluoric acid** (*hi-dro-sil-e-ko-floo-or'-ik.*) Same as silicofluoric acid, hydrofluosilicic acid."

Among the numerous tables included we find one listing 88 acids with their acid radicals (carbonic having been omitted). Other tables are as follows: 16 monatomic alcohols, 14 alizarin dyes, 19 amino acids, 25 benzene hydrocarbons, 12 desiccants [$Mg(ClO_4)_2 \cdot 3H_2O$ and ascarite omitted], dates of the discovery of the elements, 3 fatty acids, 73 synthetic indicators with pH values, 33 aliphatic hydrocarbons, 99 heterogeneous radicals occurring in organic chemistry, a periodic chain of orbital electrons of all elements, 45 proteins, 44 ptomaines, 66 silicates, 19 silver ores, 258 symbols of organic structure, 16

vegetable tanning materials, 17 voltaic cells.

Most of the sketches given have been carefully executed and well printed, but a few such as those on page 424 do not come up to the standard set for the rest of the book. Four of the six graphic representations of prisms shown on page 591 are wrong or misleading, namely, the rhombic, triclinic, trigonal, and the monoclinic. The same criticism holds true for the pyramids represented on page 602.

In looking over the pronunciations given in this dictionary the reviewer was struck with amazement that he, as well as a number of his colleagues, had been mispronouncing so many chemical terms. He felt better, however, when he discovered that Webster had also erred in a great many instances. The fact is that we have as yet no standard chemical pronunciation in the English language. What is proper to one sounds ridiculous to another. In spite of what has been said, Professor Hackh has done very well indeed. He has so simplified the diacritical marking systems that there is only a macron left. With this macron, together with the "alphabetical sounds," he has accomplished marvels. His simplified system of pronunciation is best explained in his own words: "The key to the pronunciation is the alphabetical sound of the letters. A vowel standing by itself, or at the end of a phonetic syllable, has its true sound. Any change in that sound brought about by the collocation of consonants to form the phonetic pronunciation, is corrected by a short stroke (macron) over it." He says that in phonetically spelled words, "syllabilization has been disregarded." The following key to pronunciation appears at the foot of every page: "ba, la, etc., as in day; bah, lah, etc., as far; bi, ti, etc., as mite; bu, du, etc., as you; to, do etc., as go; doo, loo, etc., as boot; ōl = pole; ol = doll; al = alley; awl = fall; āl = pale; ēl = feel; īl = file; ūl = mule; g is hard as in got."

The following words are quoted to illustrate inconsistencies and variations in pronunciation:

fluorine (*floo'-or-én*), **chlorine** (*klo'-rén*)
bromine (*bro'min*), **iodine** (*i'-o-din*)
alanine (*al'-an-in*), **cystine** (*sis'-tén*)
leucine (*lu'sin*), **lysine** (*li'-sēn*)
histidine (*his'tid-in*), **lamine** (*la'-mēn*)
nitrile (*ni'-tril; -trīl*), **benzonitrile** (*benzo-ni'-trīl*)
pyridine (*pi'-rid-in*)
propenyl (*pro'-pen-il*), **bismuthyl** (*biz'-muth-īl*)
permutite (*per'-mu-tīt*), **cinnamyl** (*sin'-am-īl*)
fumaryl (*fu'-mar-īl*)
crotonyl (*kro'-ton-īl*), **Ångström** (*ang-strem*)
tolane (*tol'-ān*)
phenolphthalein (*fe-nol-tha'-le-in*)

This list could be expanded to great length but enough has been given to show the need of standardization. It will also be noticed that the author uses no secondary accents nor does he distinguish between the tilde, circumflex, and breve sounds.

Without especially hunting for missing words, the reviewer noted that the following were absent: dehydrite, sorel cement, rhenium, humic acid, isamic acid, carnaubon, phenylthiohydantoic acid, fluoplumbic acid, chlorazide, vanadol, hydrolith, Abbé refractometer, Knoor alkalimeter, Victor Meyer and Menzies molecular weight apparatus, Jones reductor.

Regardless of the above adverse criticisms, the reviewer feels that Professor Hackh has produced the best and most serviceable dictionary of its kind in the English language. It is surprisingly complete, and the workmanship is excellent. Only two minor typographical errors were discovered, and the reviewer takes off his hat to Blakiston's Son and Company, Inc., for having given us a well-nigh perfect product of so difficult a piece of printing.

C. A. JACOBSON

WEST VIRGINIA UNIVERSITY
MORGANTOWN, W. VA.

Experimental Physical Chemistry. FARRINGTON DANIELS, Ph.D., J. HOWARD MATHEWS, Ph.D., Professors of Chem-

istry, and JOHN WARREN WILLIAMS, Ph.D., Assistant Professor of Chemistry, all of the University of Wisconsin. McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City, 1929. xvi + 475 pp. 20 × 14 cm. 131 figures. $3.50.

"This book purposes to illustrate the principles of physical chemistry, to train the student in careful experimentation, to develop familiarity with apparatus, to give the student confidence in using physical chemical measurements, to encourage ability in research. . . . Some of the experiments are new, some are based on researches described in the literature, and some are classical."

The reviewer feels that the stated purposes of this book have been met very successfully. He does not feel, however, that this is quite the laboratory manual for students who are taking physical chemistry for the first time, *unless accompanied by mimeographed instruction sheets.* Under these conditions it would be excellent. For more advanced students and as a general reference book it could scarcely be improved. The reason for the restriction named is that beginning students usually require somewhat more explicit directions than are given. In short the reviewer differs with the authors in believing that for beginners it is wisest to use the imperative.

The book is divided into three parts. **Part I** describes 78 laboratory experiments; **Part II** describes the construction and use of a very wide variety of physical chemical apparatus; and **Part III** describes the very important miscellaneous operations of the laboratory. There are also tables for correcting a barometer for temperature, vapor pressure and density tables for water, and a four place logarithm table. The "Comments Concerning Laboratory Work" are short and very much to the point.

The laboratory experiments fall under the following chapter headings: Gases, Liquids, Optico-Chemical Measurements, Solutions, Thermochemistry, Colloid Chemistry, Phase-Rule Studies, Chemical Equilibrium, Reaction Rates, Electrical Conductance, Electromotive Force, Electrometric Titrations, Electrode Phenomena, Capacitance, Electrochemistry of Gases, Radioactivity, Photochemistry. Each experiment is outlined as follows: Theory, Apparatus, Procedure, Calculations, Practical Applications, Suggestions for Further Work, References. The reviewer is especially pleased with the inclusion of the somewhat unusual fifth and sixth items. The references are abundant and well chosen.

Since "Experimental Physical Chemistry" is a rather ambitious work, one may inquire why a chapter on "Errors" was not included. Appreciation of the actual value of experimental data is something that any laboratory course in physical chemistry must aim to develop.

In conclusion the reviewer wishes to congratulate the authors on a really excellent piece of work, to recommend it most heartily to all teachers and advanced students and to beginners as a very valuable reference manual to own.

MALCOLM M. HARING

UNIVERSITY OF MARYLAND
COLLEGE PARK, MD.

Modern Scientific Knowledge of Nature, Man, and Society. FREDERICK A. CLEVELAND, Ph.D., LL.D., Professor of United States Citizenship on the Maxwell Foundation, Boston University; formerly Director of Bureaus of Municipal Research, New York and Philadelphia; Chairman of President Taft's Commission on Economy and Efficiency, etc.; author of "Growth of Democracy in the United States," "Railroad Promotion and Capitalization;" "Chapters in Municipal Administration and Accounting;" "American Citizenship," etc., with Collaborators. The Ronald Press Company, New York, 1929. xxvii + 592 pp. 14.5 × 21 cm. Illustrated. $4.50.

This curious book has a number of good points and a number of bad ones. Its

bad qualities are pretty evident and will probably impress the reader adversely at the outset. Its good points will appear when the book is read. The reviewer has found that a careful examination dulled greatly, or almost neutralized, the first unfavorable impression and convinced him that the book is very much better than it at first appears to be. The fourteen collaborators have done their part and have chosen their material wisely and well, but their contributions have plainly suffered from too much editing. The effort to unify the whole account has mangled it in many places. It would undoubtedly have been a better book if it had been written by one man, or, lacking that, if the reader had been offered the clear exposition of one expert, then the clear exposition of another—and had been allowed to synthesize the various opinions for himself. The intelligent reader will probably insist upon the latter alternative anyway.

The book covers the whole realm of general science and supplies a textbook for an orientation course in which the student is given a broad survey of man's knowledge about nature and about man individually, and in the group. The original manuscripts of the chemistry sections were prepared by Lyman C. Newell and by Ralph N. Maxson, both well known to the readers of THIS JOURNAL. That on astronomy was prepared by Harlow Shapley, perhaps the most distinguished of living astronomers. Some of the other collaborators are well-known and distinguished specialists in their various branches of science.

Each chapter is followed by a "Questionnaire with Reading References" which seems a needless irritation—for most of us have had enough of questionnaires. Each question is followed by a list of books which bear upon it, and the particular page upon which a discussion of the question may be found is generally noted—a detail which is distinctly unfavorable to productive scholarship. The book contains many paragraphs which will make the student wish for more, and a number which do not contain enough to insure a proper understanding of their meaning. It is supplied with a really excellent index.

TENNEY L. DAVIS
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS

Practical Chemistry with Experiments. LYMAN C. NEWELL, Ph.D., Professor of Chemistry, Boston University, Boston, Mass. Revised edition. D. C. Heath and Co., New York City, 1929. **Part I. Practical Chemistry.** viii + 543 pp. 24 tables; 139 drawings; 95 photographs. **Part II. Experiments in Practical Chemistry.** viii + 168 pp. 114 drawings. 12.5 × 13.19 cm. $2.24.

The text (**Part I**) and the manual (**Part II**) are bound in one volume. This second edition is more attractively bound than was the first (1922) one. The quality of the binding of the new book is good; however the cloth part spots somewhat. The thickness (3.6 cm.) of the book is, perhaps, too great for the other dimensions. The paper stock will withstand very well the customary usage accorded a first-course chemistry book; it allows too free a flow of fountain-pen ink.

The paragraphing is well done; the section heads show excellent composition, both from the standpoint of directing the reader's attention and also for purposes of ready reference. These headings are printed in 11–12 point, bold-face type; the main body of the text in 11–12 point; and the less important section of the text, exercises, problems, and the main body of the manual in 8-point. The type is neat and easily read, it being probably *monotype modern* or *monotype Caslon*. The reviewer found no typographical errors but he was slightly disconcerted by an avoidable amount of broken type.

In the main the drawings are very well executed. Conventional perspective outline shading would have added to the reality of the three-dimension drawings. The customary broken section conventions

are almost totally ignored. In some instances the ends of open glass tubes are closed and in others are left open. These are minor considerations, but the observation of them would add to an otherwise well set-up book. The photographs are well chosen and excellently printed.

It is unusual to find an inorganic text and manual combined under one cover. This arrangement has the merit of a greater assurance that the student will have the text available for reference purposes while in the laboratory. The combination cannot, however, be satisfactorily used in the elimination from the text proper of the partial description of certain of the laboratory experiments.

The reviewer had access to the first (1922) edition of the text but not to the previous edition of the laboratory experiments. A hasty comparison shows: (1) that certain paragraphs in Chapters XXVI (Metals and Non-Metals—Periodic Classification) and XXXVIII (Radium and Radioactivity) were revised and extended; and (2) the addition of Chapter XXXIX (Electrons)—these changes and additions being in conformity to more recent fact and theory relative to the nature of matter. The index is increased accordingly. The Appendix lists 53 (an addition of nine) sources of related and detailed outside reading.

The text is "intended for the first year of chemistry." The author states, "it is a Practical Chemistry—practical in several ways." The author is modest, as his statemen leaves the impression that his treatment of the subject is devoid of theory. Such is not the case, for there are in the book brief but adequate presentations of: (1) the atomic, kinetic, and ionization theories; (2) valence; (3) structure of the atoms, etc. Of the 421 exercises and 274 problems, quite a few deal with theoretical chemistry.

The general sequence of topics is excellent. The student is quite early but very unostentatiously introduced to such subjects as symbols, formulas, equations, and atoms. These terms and abbreviations constitute some of the fundamentals of the language of chemistry—hence why not this early introduction of them? The displacement (chemical activity) series is briefly used in the chapter on hydrogen (p. 42), and there is no particular reason for not utilizing this series as early as the chapter dealing with oxygen. The pages concerned with molecular weights, formulas, atomic weights, and valence are masterpieces of clarity and simplicity. The extensive lists of the practical uses of the various substances lend a wholesome pandemic tenor to the subject.

Solutions and colloid chemistry are given scanty space in the chapter on water. The dangerous nature of definitions is well recognized by the author as exhibited by the fewness of them. The chemistry of condensed acids and their salts is not mentioned. Early in the book, chemical change is discussed without reference to the accompanying energy changes; a little later chemical change is extended in the light of the electron theory. The use of electronics is avoided in the sections dealing with oxidation and reduction. The metallurgy and refining of copper is presented at some length. The double-arrow (⇆) is used in the sections pertaining to equilibrium reactions, but thereafter avoided. The statement "about 85 elements" is to be found on p. 7; 85 elements are listed in the "Table of —— and atomic weights;" and only 70 are included in the "Periodic Classification." The reviewer regrets that the *Chemical Abstracts*' spelling of *aluminum*, *sulfur*, and *buret* is not followed.

Part II (Experiments in Practical Chemistry to Accompany the Text) contains 238 exercises. According to the author, "Several experiments have been revised and minor corrections made in this edition." The first experiments are given in ample detail, while the later ones are more abbreviated. Attention is also given to the selection of experiments involving the lesser costs for materials. The technic in pouring liquids (Figures XV and XVI) could be improved. The other general in-

structions in the "Introduction" are excellent except that "carron-oil" for burns is no longer on the favored list of first-aid treatment.

The absence of apparatus supports in the diagrams may leave too much to the ingenuity of the student. The title "Effect of Shape on the Solubility of a Solid" is misleading. Hydrated sodium acetate is probably a more interesting substance for the study of "super-saturation" than is sodium thiosulfate. The familiarizing of a first-course student with a hydrometer is commendable. Some of the analytical determinations are worthy of an excellent first-course manipulator.

The manual affords a wide latitude in the choice of experiment and is a veritably excellent accompaniment for the text.

In conclusion, the reviewer recommends the volume for the use of students who have not had any previous training in chemistry.

JESSE E. DAY
THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO

BULLETINS

Record of Current Educational Publications. *Dept. of the Interior, Bureau of Education, Bulletin,* 1929, No. 24. U. S. Government Printing Office, Washington, D. C. 128 pp. $0.15.

This bulletin comprises publications received by the Bureau of Education, January–December, 1928, with index.

Statistics of Private High Schools and Academies, 1927–1928. Prepared in the Division of Statistics by Frank M. Phillips, Chief. *Dept. of the Interior, Bureau of Education, Bulletin,* 1929, No. 19. U. S. Government Printing Office, Washington, D. C. 61 pp. $0.10.

The Saline Springs of the Rio Salado, Sandoval County, New Mexico. JOHN D. CLARK, Professor of Chemistry, University of New Mexico. Univ. of New Mexico Bulletin, Univ. of New Mexico Press, Albuquerque, New Mexico, 1929. 29 pp.

A complete description of these springs with numerous excellent illustrations.

Optical Rotation and Ring Structure in the Sugar Group. The Optical Rotation of the Various Asymmetric Carbon Atoms in the Hexose and Pentose Sugars. H. S. ISBELL, Associate Chemist, Bureau of Standards. *U. S. Dept. of Commerce Publication.* **Research Paper No. 128.** Reprint from Bureau of Standards, *Journal of Research,* Vol. 3, Dec., 1929. Supt. of Documents, Washington, D. C. 12 pp. $0.05.

The Detection and Investigation of Poisons by Spectroscopy. Adam Hilger, Ltd., 24 Rochester Place, Camden Road, London, N. W. 1, England. Dec., 1929. 17 pp.

The material in this pamphlet is divided into three parts: I. Applications; II. Equipment; III. Method of Working.

Professor A. F. Holleman Honored. Professor A. F. Holleman, the eminent Dutch organic chemist, attained his seventieth birthday on August 28th, and a special volume of the *Recueil des Travaux Chimiques des Pays-Bas* has been dedicated to him in honor of the event. The volume contains numerous papers, from Dutch, British, American, German, French, and Italian authors. Much of Professor Holleman's published work deals with the directive effect of substituents in the benzene nucleus on new substituents entering therein. He is also widely known for his *Text-Book of Organic Chemistry,* which has been used by many generations of students. Originally written in Dutch, it has run into six English editions, and has also been translated into German, Italian, French, Russian, Polish, Spanish, and Czechoslovak.—*Chem. Age*